POWER

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Diesel Economics

No power plant operating on a single-fluid cycle has seriously approached the oil engine in thermal efficiency in the present art of power production. In Europe it is used extensively even in countries where fuel oil, compared with coal, is more costly than in the United States. It is made in larger sizes and has a wider acceptance for all purposes abroad than here.

Now there are some good reasons for this and for the most part they are traceable to the manufacturers. This is said with full cognizance of the numerous present economic reasons that appear in contradiction. The basic facts go further back and are probably the outcome of failure on the part of pioneer builders to appreciate that oil engine design demanded a better understanding of principles than the ordinary garden variety of steam engine. The early mistakes in oil engine construction were amplified by lack of vision as to the scope of its applicability.

Another error, and an important one, was in permitting the belief that the oil engine was a natural enemy to steam instead of its ally. It is only now that some semblance of realization of these former shortcomings is being sensed.

Time will tell whether the industry is equal to the task of its own salvation.

EDITORIALS

Small Plant Smoke Problem

As time goes on it becomes increasingly apparent that there is a decided concentration of research and design upon the necessities for controlling objectionable stack discharge from large utility and industrial power plants. The last word in progress is far ahead of us, it is admitted, but there are at least many signs of substantial advance, far more in fact than is the case of similar engineering and research in the interest of the smaller industrial power plants.

Present-day economics indicate plainly that the small industrial power plants are in a decidedly favorable position as producers of cheap power, but their protection against smoke and fume discharge is backward when compared to the work in this field among the larger plants.

Organizations engaged in the production of power plant machinery for the smaller individual needs should be giving attention not only to the problems of improving their regular line of equipment but to supplementing it with suitable apparatus designed to conform to the demands of present-day smoke ordinances. This means not only that the boiler settings shall be proper for suitable combustion, but that small-scale apparatus shall be developed for the effective collection of cinders, soot, sulphur and fly ash.

As undoubtedly the time is not far away when all plants will be required to include fly ash or cinder catchers as a part of their original installation, those manufacturers who are prepared to meet this challenge will do the business.

Some Call It Economy

Now, if ever, is a time for clear thinking. A first step is the abolition of all slogans and formulas that are used to replace the analysis of actual conditions. Among these are "No Unnecessary Expenditures."

Designed to prevent waste, it often works just the other way. It means—or men take it to mean—"buy nothing now that you can get along without for a while." Working on that theory the slum housewife buys a hod of coal because she won't need the rest of a ton for some days to come. The industrial manager buys one hundred tons of six-dollar coal because the money layout *today* is less than if he paid to revamp his firing equipment so that it would give the same efficiency with four-dollar coal.

In another plant the steam wasted this month is (perhaps) less than the total investment in new traps to stop the leaks. Therefore the new traps are an "unnecessary expenditure postponed to better times."

No need to multiply illustrations. The man who buys today only what he can't get along without today, and does not discriminate between "expense" and "investment,' will never get rich. And some call it economy!

Do Not Stop Gathering Of Water-Supply Data

Appropriation-cutting in Washington, now in full swing, threatens curtailment of many essential activities. Among these is the Geological Survey's work of obtaining data on water resources, which include rainfall, stream flow, ground-water levels, and other records. Part of this work is done in cooperation with state and other agencies, the expense being shared by the various interests. Any curtailment of these activities by the Federal Government involves an equal reduction by the co-operating agencies.

Adequate information on our water resources is, in many instances, woefully lacking. A comprehensive knowledge of water supply can be had only by years of continuously recording rainfall, runoff, stream flow, and other correlative factors. Any interruption of these records may seriously affect their value and proportionately detract from the justification of the years of previous effort.

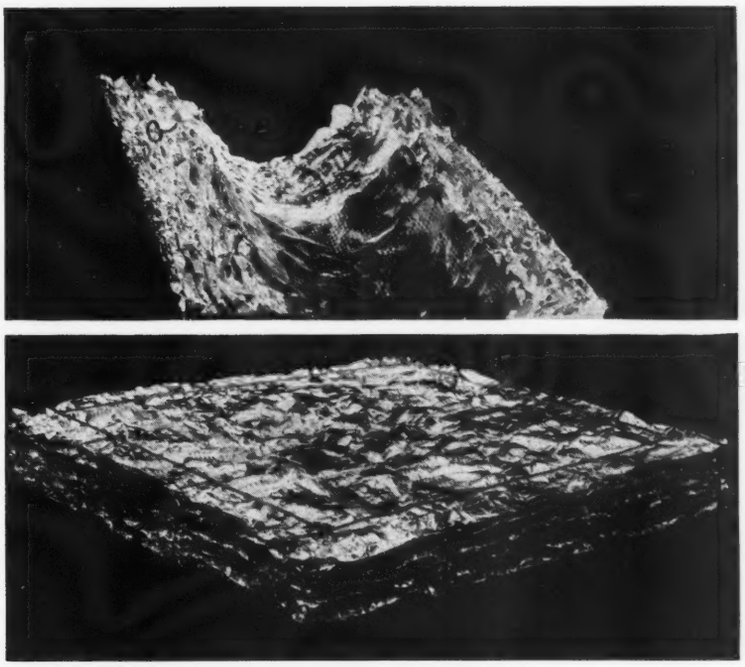
Not only is there an increasing demand for data now obtained by the Geological Survey, but the requirements for more complete information on water supply are becoming more urgent. An instance of this is the present necessity for data upon the relation between ground-water level and runoff that has developed as a result of last year's drought. Very little information is available on this important matter. Through the efforts of the hydraulic power committee of the Pennsylvania Electric Association and with the cooperation of the U. S. Geological Survey and the Pennsylvania Geologic Survey, records of ground-water levels are now being obtained from thirty-five wells in that state. This work is just getting nicely started and any restriction of government expenditure that would curtail it can only result in a serious loss of valuable data, badly needed.

Our water resources are among the nation's most valuable assets. Appropriations for their study have constituted an investment that has steadily increased in value and will continue to do so with increasing demands for water in power generation, municipal supply, irrigation, industrial processes and for other purposes. It is ill-advised economy to reduce the already inadequate funds now appropriated for their study.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason



Figs. 1 and 2—A section of insulation (above) showing how foil is crumpled and panel of crumpled foil (below) for insulating flat surfaces

Aluminum Foil —A Heat Insulator for Power Plant Equipment

When properly installed, aluminum foil offers high resistance to heat transfer, is light and unaffected by moisture

AS ALL metals present relatively low resistance to the transfer of heat, it cannot help but appear paradoxical to use aluminum as a basic material for heat-insulating purposes. Therefore, before indicating how aluminum foil can be applied to power plant equipment for this purpose, an explanation of how it acts as an insulator will be given.

The aluminum foil is used to form air spaces the optimum economical thickness of which has been found to be about $\frac{3}{8}$ in. The use of foil in this way was first suggested by Prof. Dr.-Eng. Ernst Schmidt as a result of research and tests at the University of Munich, Germany.

Heat is transferred across an air space in three ways, by radiation, by conduction and by convection. Of the total heat transfer across a 0.5 in. air space bounded by surfaces equal to that of a black body about 76 per cent is transferred by radiation, $2\frac{1}{2}$ per cent by convection and 21 per cent by conduction at a mean temperature of 212 deg. F.[1] At 900 deg. F. the heat transferred by radiation increases to about 95 per cent of the total. The radiation from most building materials closely approaches that of a black body, so that the above percentages apply to the heat flow across most air spaces. The importance of radiation in heat transfer is further illustrated in the curves of Fig. 3, which show the heat loss from bare pipe separated into two component parts of radiation and convection.

Still air is the best insulating medium known, the heat transfer coefficient for it being about 0.195 B.t.u. per square foot per hour per degree per inch thickness at a mean temperature of 212 deg. F. The heat flow by convection across a one-half inch air space may vary from about 0.3 to 0.5 B.t.u. per hour per square foot.[2] It is thus evident that the heat transfer across an air space would be reduced to a low value if the heat transfer by radiation could be reduced.

A material reduction in radiation is possible by making the surfaces bounding the air space of bright or polished metal. Aluminum is well suited for this purpose, because its surface is naturally bright and is not dulled by the action of air or sulphur fumes. Tests show that it radiates only about 5 to 6 per cent of the heat radiated by a black body, and the thin oxide film formed on its surface has practically no influence on the heat radiated from it.

If aluminum surfaces are substituted for black-body surfaces the percentages of the total heat transfer across a one-half inch air space at a mean temperature of 212 deg. F. become: radiation, 9 per cent; convection, 9.5 per cent; and conduction 81.5 per cent. And since the heat flow through air by conduction is low the total heat flow is about one-quarter of that transferred when the air space is bounded by black-body surfaces.

By placing in series a number of air spaces bounded by aluminum foil an effective insulation against heat transfer can be obtained. The number of air spaces or

[1]Dr. S. Raisch, Institute for Heat Insulation, Munich.

[2]E. R. Queer, Pennsylvania State College.

layers of foil to be used depends upon the temperatures of the surface to be insulated and the efficiency of insulation.

Two methods have been employed to apply aluminum foil to the surface to be insulated. The more efficient insulation, as far as thermal characteristics are concerned, is obtained by stretching plain foil over spacers or frames made of wood, asbestos or other similar material. This method has certain practical disadvantages.

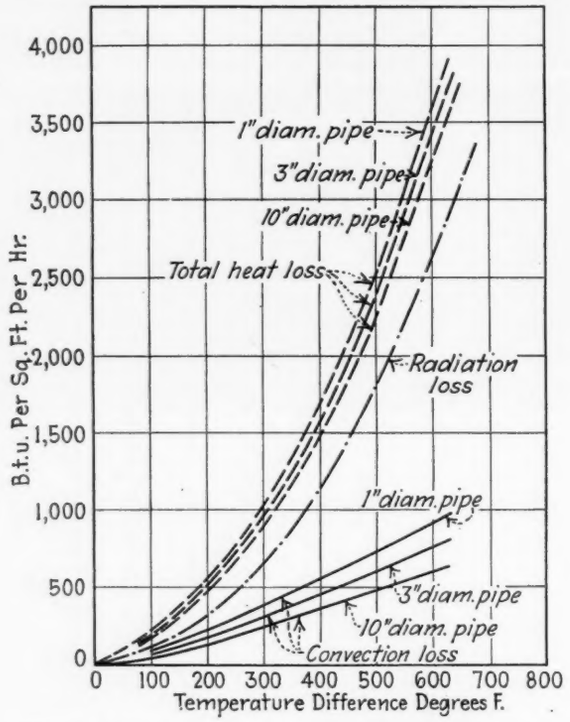
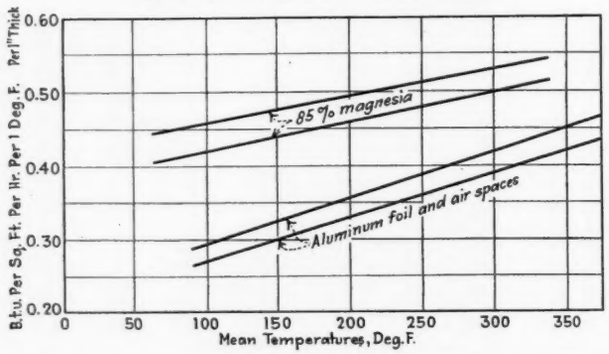
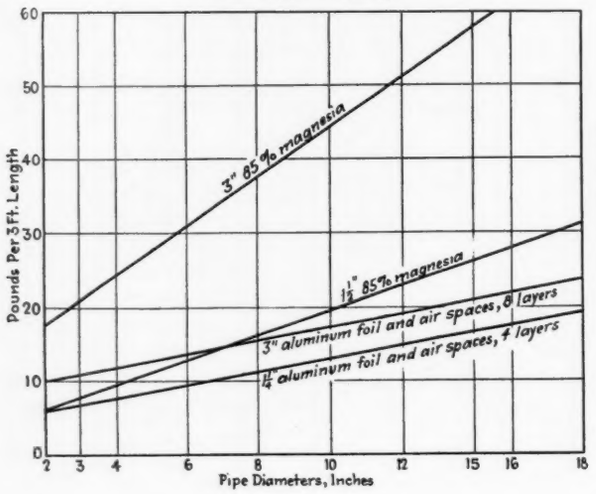


Fig. 3—Heat loss from bare pipe separated into components of radiation and convection





A more easily applied and therefore cheaper insulation is obtained by building up layers of foil crumpled so as to form irregular ridges and valleys throughout the sheet. Thus the foil provides its own spacing. For this type of insulation embossed foil 0.0003 in. thick is used. The embossing is an aid to the hand-crumpling process and the heat transfer through the foil by conduction is quite small, due to its thinness and the limited area of contact. In both cases the aluminum foil must be protected from crushing.

Insulation of these types has been tested in the research laboratories of the Massachusetts Institute of Technology, Pennsylvania State College, Battelle Memorial Institute, United States Navy, and Mellon Institute of Industrial Research. The conductivity constants determined at these various laboratories are in close agreement. The heat loss in British thermal units per square foot per hour per inch thickness per degree Fahrenheit for crumpled and plain aluminum foil is shown by the curves in Fig. 4 in comparison with the heat-flow constants for 85 per cent magnesia.

For pipe insulation the embossed foil taken from a 16 in. wide roll is crumpled by hand, cut to length and wrapped around the pipe in successive layers until the desired thickness is obtained. Five layers will give an insulation about 2 in. thick. The longitudinal joints are staggered and the transverse joints are overlapped slightly. At about 36-in. intervals, wedge-shaped iron spacers are strapped around the pipe. A piece of $\frac{1}{8}$-in.-dia. wire is wound on top of the spacers. This structure forms the base for supporting the metal case of about 26 gage iron sheet, which is held in place by metal straps or spot welding.

For insulating flat surfaces, panels of foil as shown in Fig. 2 can be made, or the crumpled foil may be hung over wire stretched between a supporting structure. The method of holding the supporting wire and of fastening the protecting metal case depends largely upon local conditions.

Fig. 5 shows the weight of 3-ft. sections of aluminum foil insulation including the metal jacket for various thicknesses and pipe diameters. For comparison the weight of 85 per cent magnesia insulation is also shown.

Fig. 4—Heat transfer coefficient for aluminum foil and air spaces including metal jacket

Fig. 5—Relative weights of three foot section of 85 per cent Magnesia and aluminum foil insulation

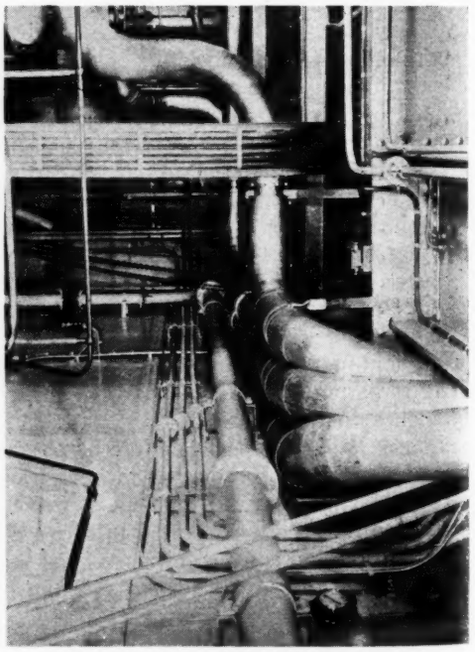
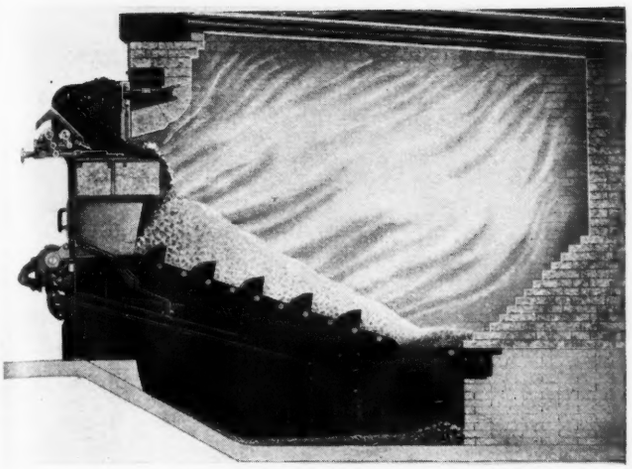


Fig. 6—Piping on board the S.S. San Francisco is insulated with aluminum foil



View of typical overfeed stoker installation

Efficient Operating and Banking Methods With Overfeed Stokers

By H. M. SPRING

PROBABLY the majority of operating engineers are not as familiar with the overfeed type of stoker as with others and some operating pointers supplementary to manufacturer's instructions may prove beneficial. The overfeed stoker may be divided into two classes, the front-feed, and the side-feed opposed-stoker type.

In general, an overfeed stoker may be used to burn most coals. It is, however, used frequently to burn the caking coals which require grate agitation for successful burning. Automatic rocking grates provide agitation, and coal is fed from the base of the hopper by a reciprocating pusher plate. With the side-feed type the opposed firing effect results in a higher furnace temperature than is obtained with the front-feed type. This gives better ignition but limits the rate at which the maximum output of the stoker is set, by the fusing temperature of the ash. If coal containing an ash of low fusing temperature is used excessive slagging between boiler tubes or on furnace side walls is almost sure to follow. With the side-feed stoker a nearly level fuel bed should be carried at about a 4-in. maximum depth. A clinker grinder is used with this type of stoker.

There are many methods of starting a fire with the overfeed stoker. It would be unwise to say that there is any one best method of doing this that would apply in every case, but one method which has proved successful in many installations is as follows. The grates are first covered with paper, shavings and other refuse; then old boards, boxes and other wood refuse is thrown on the top. With a light draft and no agitation or coal feed this is ignited. When it is burning good more wood and a layer of lump coal is thrown in on the front part of the grates. The coal feed is then started at slow speed and short stroke. The draft is gradually increased as the fire works toward the rear. When the fire has burned through about half way back the agitation of the front grate section should be started. By the time the entire ashpit shows red the fire will be in proper shape for load on the boiler, and coal pushers and agitators may be placed in normal operating position.

In operation there are two items to be given close attention—excessive smoking and excessive sifting of the finer coal into the ashpit. With careless and unnecessary use of hand fire-tools either sifting or smoking or both is likely to result. After the fire is built up to its proper depth the only use of a hand fire-tool until banking time should be for the working of a clinker down onto the dump plate. A clinker on the grate will be evidenced by a dark spot in the red light of the ash pit. Sifting will also be caused by too much agitation for the thickness or condition of the fuel bed. Smoking may be practically eliminated when forcing the fire at peak loads by the admission of air over the fuel bed in proper amount. A good average depth of fuel bed will be 7 in. deep in front, sloping to a 3-in. or 4-in. in the rear by the dump plate. With this fuel bed and a properly designed furnace a combustion rate of 35 lb. of coal per hour per square foot of grate surface should be attained in the average plant.

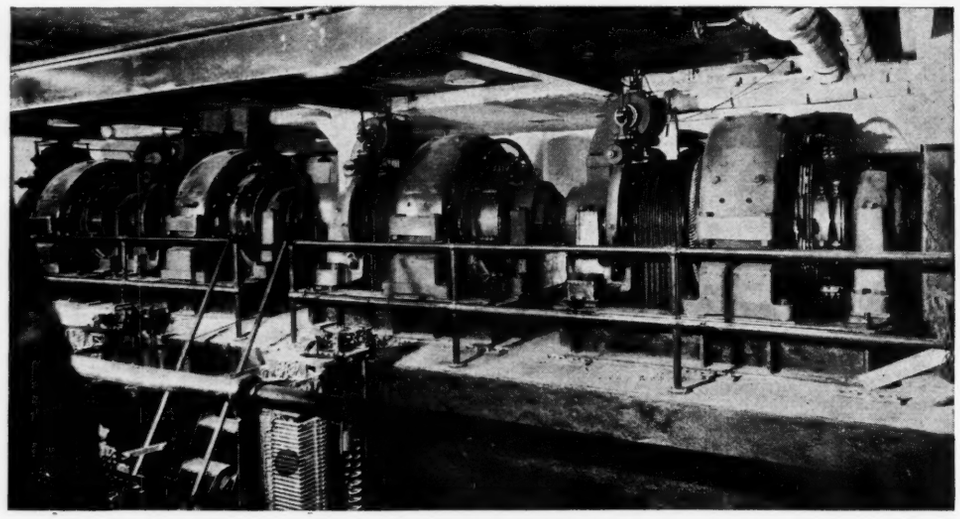
Another loss is that due to excess air. This is more apparent than other difficulties, as it is often due to the rear section of grate being bare at light loads. Obviously the remedy is to carry a thinner fire and cover the entire grate surface. A lower draft should be carried.

The dump plate provided in the front-feed stoker should be locked closed when not in use. As the ash and clinker accumulate on it the dump plate should be opened, dropping the ash into the pit. The dump plate should immediately be closed and the ash and clinker in the pit be wet down and removed to prevent overheating of the lower grate section or dump plate.

When the coal pusher is stopped for short periods, less than an hour, the pusher plate should be left at the end of its inward travel to prevent possibility of a fire burning back into the hopper. For this same reason the hopper should always be left empty when the fire is banked.

The best method of banking the fire will also depend on the particular case, and on the length of time to be banked, furnace design, etc. When the fires are to be banked the agitation of the front grate section should be cut out and the coal pusher stopped. The grate agitation of the middle and rear sections is increased to maximum, with maximum draft. When nothing is left but ash and clinker this is pushed back onto the dump plate with hand tools, dumped, and cleaned out. This should leave the grates all clear but the front section, where a small amount of live coal is heaped. The air is then shut off and the coal pusher started. After the hopper is empty the stoker may be shut off and the bank left until starting up. If trouble is had by an excessive amount of coal gas filling the furnace there is some danger of an explosion. In such a case the stack damper in the breeching should be left cracked open just enough to keep the furnace clear without causing the bank to burn through. If difficulty is had with the bank burning through too quickly the amount of live fire used in the bank should be reduced, until in some cases the bank is made entirely of green coal with no live fire at all. In such a case ignition takes place at each end of the bank from the heat of the brickwork and gradually burns toward the center.

If an overfeed stoker is correctly installed in a furnace of proper proportions and the stoker is operated with methods most suited for the particular installation, even a small plant should show an efficiency in the boiler room that will compare favorably with the larger plants.



Four of the eight direct-traction hoisting machines on the high-speed double-deck elevators

Double-Deck Elevators in the Cities Service Building Go Into Operation

In the 67-story building of the Cities Service Company, New York City, there are 26 elevators, eight of which are high-rise machines equipped with double-deck cars operating at 1,000 feet per minute

FOR the first time in the history of building construction double-deck elevators have been installed in a skyscraper. The building is the new 67-story home of the Henry L. Doherty and Cities Service companies at Cedar, Pine and Pearl Streets in New York's downtown financial district. This forward step in vertical transportation, now permitted by special provision in the new elevator code, has long been awaited by the industry to help solve the problem of tall-building economics.

Strict building laws in New York and other large cities often reduce tower areas to such an extent that one of two equally undesirable alternatives result: either the elevators require so much floor area that adequate rentable space cannot be obtained on the tower floors, or the number of elevators is reduced at the expense of good service. It had long been felt by architects and engineers that increasing the handling capacity of an elevator hoistway is the only means out of the difficulty. Experiments with double-deck elevators have been in progress for several years, simultaneously with the movement to have the code revised to permit that type of elevators in high buildings.

In the Cities Service Building eight high-rise, double-deck Otis elevators, operating at 1,000 ft. per minute, serve all floors from the 29th to the 63d. The intermediate floors are served by seven cars running local from the 16th to the 29th, and the lower floors by eight others. In addition, another innovation in office-building transportation has been installed—escalators to handle the rush-hour traffic between the sixth and first floors. The arrangement of elevators and escalators is shown in Fig. 2.

These double-deck elevators, aside from the two-story arrangement of the cars, are similar to the modern high-speed signal-control double-wrap direct-traction elevators now in service throughout the country. They consist of two separate compartments mounted in a single car frame, Fig. 1, or, more simply, a two-story car. They are each driven by a single hoisting machine with a full speed of 95 r.p.m. and are controlled, basically, in the same manner as the standard signal-control elevator. Both compartments are loaded at the same time, one from the ground floor, and the other

from the first floor. Passengers are discharged at the upper floors at the same time, one compartment serving only odd-numbered floors, and the other the alternate floors.

Each compartment has a capacity of 2,500 lb., is equipped with the standard signal-control operating devices and has an attendant. Trap doors are provided to permit emergency access between compartments and speaking tubes allow communication between them.

The frame supporting both compartments has an over-all height of 25 ft. Any one of the eight special-steel traction hoisting ropes is more than capable of carrying the combined weight of both compartments. Clamp-type car safeties are mounted at both the top and bottom of the car-safety frame. These safeties are set to give a positive emergency stop under full load. To assure a smooth, gradual stop with only a light load in the compartments, the mono-mass safety device is used. This apparatus is mounted on the compensating sheave in the pit. Its function, without going into the discussion of the characteristics of the law of gravity and the property of moving masses that would be necessary for a detailed description, is to so tie together the moving parts of the elevator system—the cars, hoist ropes, counterweight, and compensating ropes—that they operate as a unit mass. The result is a more uniform emergency stop regardless of the load in the elevator cars.

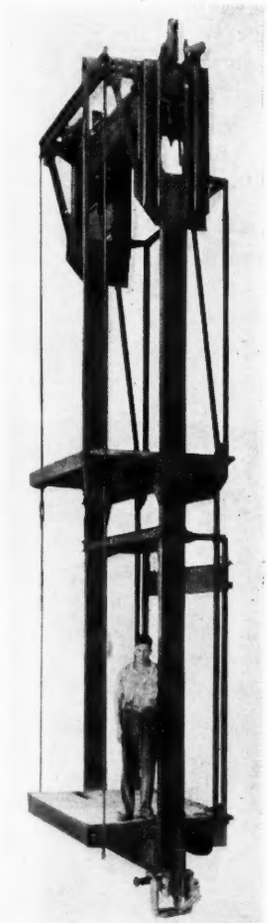
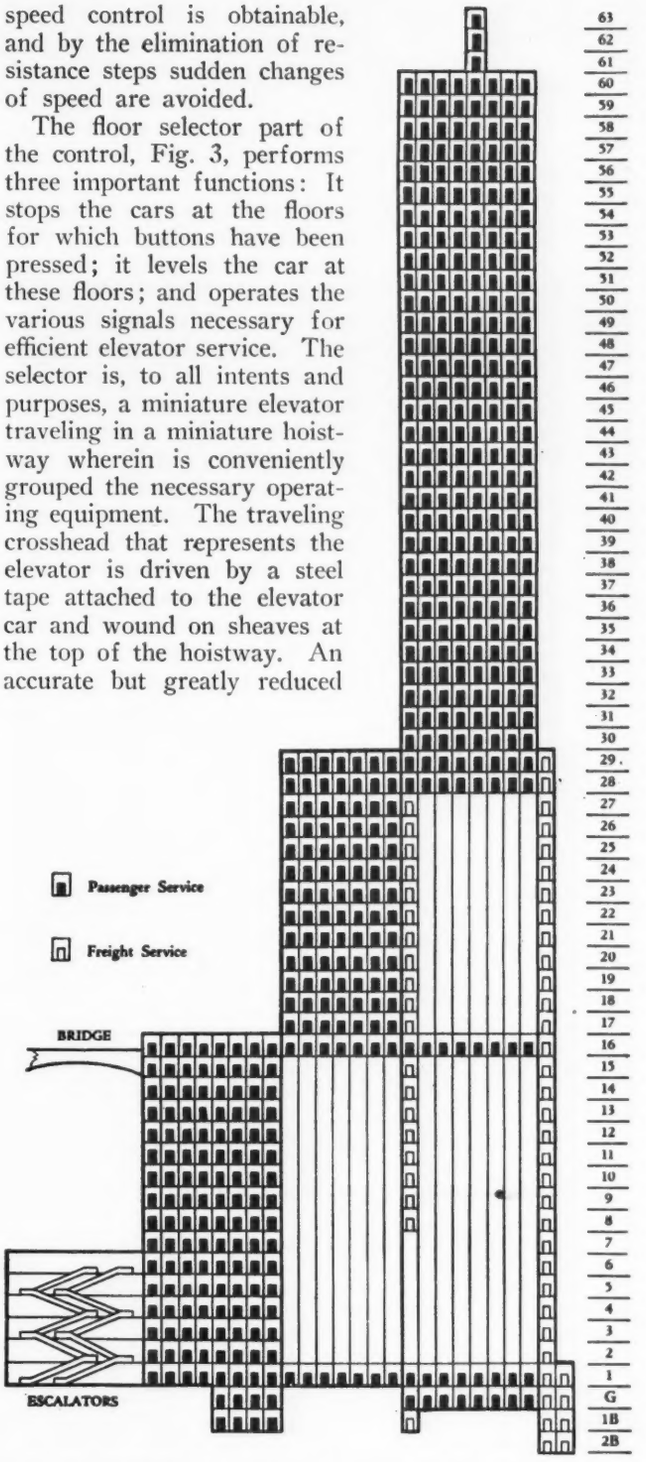


Fig. 1—The frame supporting both compartments of the double-deck cars has an over-all height of 25 feet

Other safety features, common to the ordinary high-speed elevators, include oil buffers in the pit, automatic stopping devices for the top and bottom terminals, and electric contacts to prevent operation until all hoistway and car doors are closed. Because there is occupied space beneath the hoistways, it has also been necessary to provide safeties at top and bottom of the counterweights.

Unit multi-voltage control is used and includes an individual constant-running motor-generator set for each elevator. The armatures of the generator and the elevator motor are permanently connected electrically, and the speed of the motor is controlled by the adjustable voltage obtained directly from the generator. This voltage is regulated by control of the generator field. Thus the controller switches carry only auxiliary and field currents and are of smaller size and simpler design than if armature currents were handled. Heavy resistance losses are eliminated. A wide range of speed control is obtainable, and by the elimination of resistance steps sudden changes of speed are avoided.

The floor selector part of the control, Fig. 3, performs three important functions: It stops the cars at the floors for which buttons have been pressed; it levels the car at these floors; and operates the various signals necessary for efficient elevator service. The selector is, to all intents and purposes, a miniature elevator traveling in a miniature hoistway wherein is conveniently grouped the necessary operating equipment. The traveling crosshead that represents the elevator is driven by a steel tape attached to the elevator car and wound on sheaves at the top of the hoistway. An accurate but greatly reduced



Elevator Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	13	26
Group	Cities Service								Intermediate Express								High Rise Express								Frt.	
Operation	Car Switch Unit Multi-Voltage Micro Leveling								Signal Control								Signal Control (Double Deck)								G-S 1 M.V. Micro	Car Switch
Capacity	4500 lbs. at 700 F.P.M.								3000 lbs. at 900 F.P.M.								5000 lbs. (total) at 1000 F.P.M.								3000 @ 600	10000 @ 75
Rise	194' 8"				220' 2"				348' 6"								719' 0"		705' 0"		746' 6"		705' 0"		348' 0"	39' 6"

Fig. 2—Diagram of the elevators and escalators in the Cities Service Company Building

The tower of the building is served by 8 double-deck express cars with a capacity of 5,000 lb., operating at a speed of 1,000 ft. per minute. The intermediate floors, from the 16th to the 29th, inclusive, are served by 7 single-deck 3,000-lb. elevators operating at 900 ft. per minute. There are also 8 local elevators, each of 4,500-lb. capacity, operating from the 1st to the 16th floors, inclusive, at 700 ft. per minute. Between the 6th and 1st floors are two flights of escalators to handle interfloor traffic.

drive is thus obtained through gear reduction between this tape-drive mechanism and the vertical screw that actuates the selector's crosshead.

Pressure on any hall or car button energizes a corresponding contact on the selector. The crosshead picks up this signal as the car nears the desired floor, and the stopping operation is initiated on the controller. The final stop at floor level is controlled by cams and contacts on the selector. Should the car run by the floor, it is brought back by the same method. Other contacts, meanwhile, have illuminated the hall lantern and operated lights in the hall and car-position indicators. Pressure on a hall button sets up this stopping signal for all elevators, and the first car to pick up the call on its selector cancels it for all other cars.

Every second that can be cut from an elevator's round-trip time will show an increase in service for a bank of elevators during the day's operation. Car speed alone is not all that is required. The double-deck elevators are equipped with the following auxiliary apparatus to assist in increasing their passenger-carrying efficiency.

High-speed, motor-driven door-operating machines located on each car automatically open the car and hoistway doors as the car reaches floor level. The machine closes the doors when the operating switch handle is advanced to the start position. The operation of the machine is controlled by switches mounted on a panel in the machine room. In addition to automatic operation of the doors, their movement may also be controlled at will by the attendant in the car.

Over each hoistway door are located hall lights and single-stroke bells to indicate to waiting passengers the next approaching car and the direction in which it is traveling. These lanterns will not operate unless the car is going to stop at that floor. Every car is provided with an indicator in which illuminated numbers tell the position of the car in the hoistway and show the passengers when the car is approaching their floor.

An even interval is maintained between the elevators by scheduling their departure from the terminal floors and their rate of travel through the building. Lights in both compartments indicate when a car is scheduled to start or when it is running behind schedule. This device may be regulated to suit traffic conditions or the number of cars in service.

In the main elevator lobby are provided numerous lights to indicate to the starter the position of the cars and the direction in which they are traveling. Other lights show the floors at which passengers are waiting for an elevator. Switches are provided to enable the

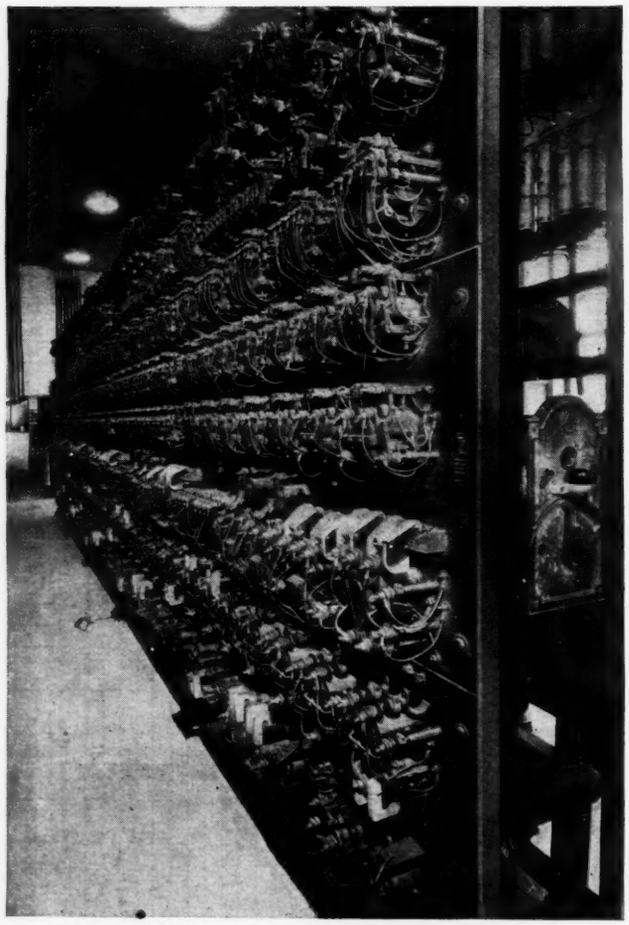


Fig. 3—A bank of control panels for the double-deck elevators. The control panel for one elevator has on it 63 different switches, relays and protective devices. The operation of a single remote-control switch will allow the entire group of double-deck elevators to be run as a bank of single-deck cars.

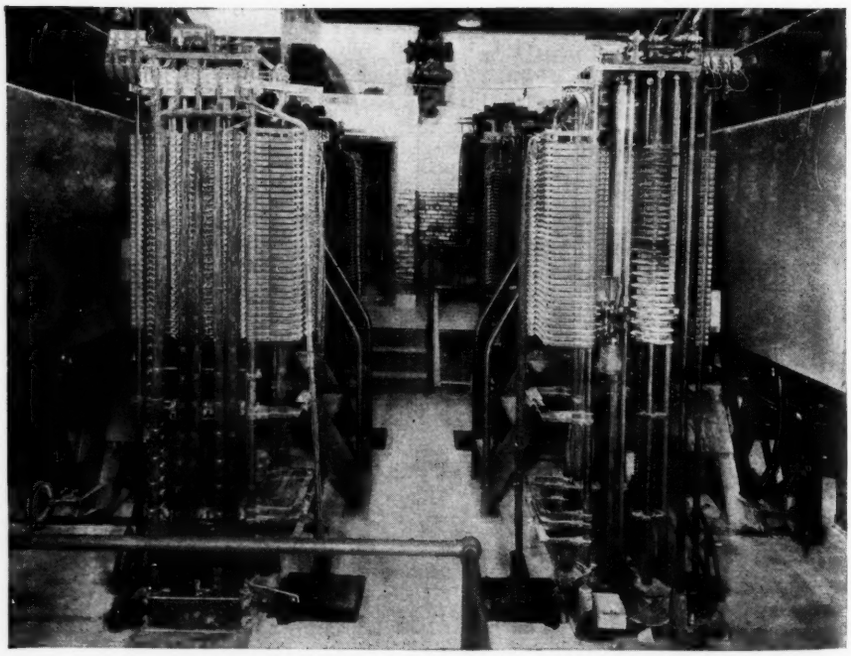


Fig. 4—Floor selectors for the double-deck elevators. The selectors perform three functions; namely, stopping the cars at the floors for which buttons have been pressed; leveling the cars at the floors; and operating the various signal devices necessary for efficient elevator service

starter to regulate the scheduling device, to non-stop a lagging car so as to bypass hall calls to the following car, and otherwise to control the operation of the elevators. The starter is also provided with a telephone and connections to all cars and motor rooms.

Double-Deck Elevator Operation

In the signal-controlled double-deck cars the variable and uncertain element in elevator operation is removed and false stops are eliminated. All operations, except the initial starting of the car, is taken out of the car attendant's hand but is under his immediate control if required. And car speeds otherwise impossible are comfortably attained and accurately controlled. Signal-control operation, for standard, single-deck servcie, may be, briefly described as follows:

As passengers enter the car the attendant registers their desired floor stops by pressing corresponding buttons in the car-operating panel. These buttons may be pressed in any sequence, before or after the car has started. When the starting signal is given by the scheduling device the attendant advances the operating handle, the doors close, automatically, and the car begins its upward trip. Travel is continued until the car automatically stops level with the first landing for which a car or hall button has been pressed. The car and hoist-way doors automatically open as the leveling operation is completed. After the passenger transfer, the attendant again advances the operating handle, the doors close, and the car proceeds to the next stop.

Each compartment of the double-deck elevator is operated by an attendant, and each is equipped with the usual signal-control car-operating devices. The elevator will start only when the operating handles of both compartments are in the full start position and all car and hoistway doors are closed. Operation of the car safety switch in either compartment will immediately stop the elevator.

The elevator will stop level with the desired floors and the doors will automatically open as with standard signal-control operation. If, however, the bottom compartment stops in response to a call for the 50th floor, for instance, and no call has been registered for the 51st floor, the upper doors will not open and the hall lantern at the latter will not light. If the hall button at the 51st floor is now pressed—and the operating handle in either compartment has not yet been advanced to the start position—the hall lantern at the 51st floor will light immediately and the doors will open. If the start has been initiated, the call will be transferred to the next approaching elevator.

A door pilot light is provided in the operating box of each compartment. This light is illuminated when the doors for the other compartment open, and is extinguished when they start to close. Each attendant is thus informed when the other compartment is ready to start.

If one compartment is fully loaded, the operation of its respective nonstop switch will render all hall calls for this compartment inoperative and transfer them to the next elevator traveling in the desired direction. The hall calls for the other compartment will not be affected and it will stop when signaled, but the doors of the first compartment will not open and the hall lantern will not light. Operation of both nonstop switches will enable both compartments to bypass all hall calls and run express to the ground floors.

In order that both attendants may know when the elevator is scheduled to leave the terminal landings, starting lights are provided in the operating boxes of both compartments and operate simultaneously. Individual remote-control switches in the starter's control panel permit any of the elevators to be operated by a single attendant, using the top compartment only. This service does not affect the double-deck operation of the other elevators.

The operation of a single remote-control switch will allow the entire group of double-deck elevators to be run as a bank of single-deck elevators. During single-deck service, all operating devices are effective from one compartment only and this compartment stops at all floors, both odd and even numbered.

Starting and stopping are so smoothly controlled that the feeling of high car speed is completely lost. The pressure of a hall button will stop the first approaching car in the desired direction without action on the part of the attendants. All operation is automatically controlled to insure maximum service; but, should occasion demand, the attendants have instant control of the operation of the doors and the car.

36 Miles of Wire Rope

Other interesting features of the elevator equipment are: The traveling cable to each of the double-deck elevators has 240 wires for connecting to the operating devices in the two compartments. On the 26 elevators in the building there is a total of 189,000 ft., almost 36 mi., of hoisting, compensating and governor rope. The length of the car and counterweight guide rails total 39,500 ft., about 7.5 miles. Over 3,650,000 ft. of rubber-covered wire and 69,200 ft. of conduit, 690 and 13 mi., respectively, were required for the installation of the elevator equipment.

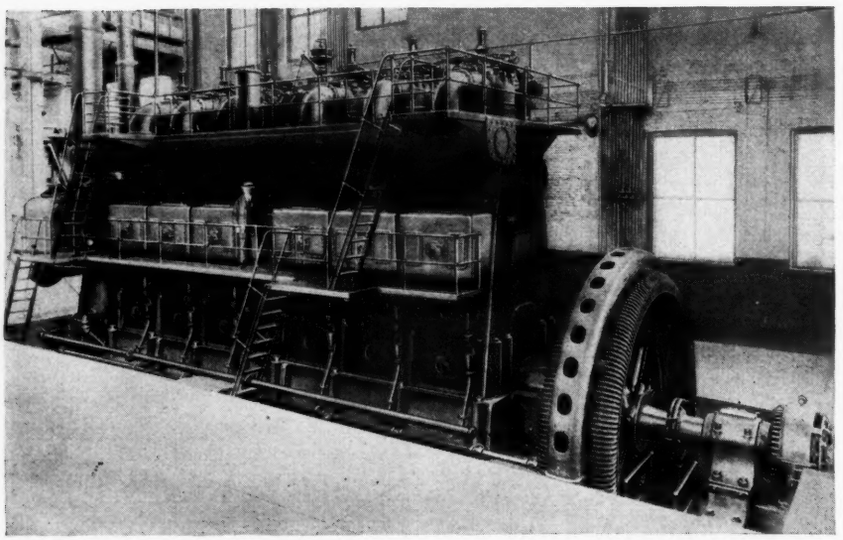
Apart from the engineering achievement which was accomplished by the Otis Elevator Company in developing the double-deck elevator, the successful operation of the system in the Cities Service Building will have a marked influence upon tall-building design and construction. In this particular building, before the elevator code was revised it was deemed necessary to install fourteen single-deck elevators to serve the floors which will be served by the eight double-deck cars. When it is considered that each hoistway requires approximately 50 sq.ft. of space on every floor, and that fourteen would have to run from the ground floor to the top of the building, it will be seen what a tremendous saving of valuable floor space was afforded by the installation. Six less hoistways of 50 sq.ft. each in 60 stories results in a saving of 18,000 sq.ft. The probable increased annual revenue, on the current basis for new buildings in the financial district, $3.50 per sq.ft. for 18,000 sq.ft. equals $63,000.

Potential Skyscraper Height Increased

What the effect of double-deck elevators will be upon growth in the height of buildings is not determinable, since so many other factors of economics enter into the decision. By this device, skyscrapers much greater in height than our present buildings are now possible, for economic elevator service has heretofore been the chief deterrent in height extension.

The architects for the Cities Service Building were Clinton & Russell, and Holton & George. James Stewart & Company were the builders.

Getting the Most For Your Oil Dollar



This type of slow-speed engine will burn oil with a high Conradson

By GERALD GROW

IT IS not exaggerating to say that at least 75 per cent of the owners of the 4,000,000 hp. of diesel engines in this country are not making their fuel dollars go far enough. Fuel oil is purchased on a more or less hit-and-miss basis, little if any study being given to the choice of a fuel that is the cheapest, all things considered. Some engineers feel that the best is none too good, so pay 7c. a gallon for a gas oil, such as is used in domestic heating systems, whereas their engines are of a type that will burn Bunker C boiler oil. But the engineer-reader naturally counters, "What is the cheapest diesel fuel?"

As the first step in developing the answer it is well to point out the desirability of using the most economical fuel. Regardless of the engine size or type, good business dictates that the most be obtained from a dollar spent for oil. But not always does a particular oil prove economical for all plants. Consequently it is desirable, in fact necessary, that the engineer appreciate the characteristics of his engine as regards its ability to burn oil and the relative maintenance expense incurred. The importance of the total plant output and the capacity factor should be appreciated, for these two items frequently justify the use of a high-priced fuel.

A 2,500-kw. diesel plant with an annual capacity factor of 50 per cent would generate 10,950,000 kw.-hr. annually, with a fuel consumption of approximately 1,000,000 gal. Even at an increase in the maintenance cost from $2 to $4 per horsepower per year, or a total increase of $5,000, the engineer could justify the use of a "boiler oil" costing, say, 1.5c. less per gallon than a 28- to 32-deg. Baumé distillate. The net saving of $10,000 per year would be 4 per cent additional return on the total plant investment. On the other hand, a plant containing a single 100-kw. unit should purchase a high-grade diesel fuel, for while the annual saving would compare favorably with that of the larger plant in percentage, the actual dollars saved would be offset by the additional labor needed in overhauling and the probable factory loss incurred by enforced shutdowns in working hours.

It must be understood, however, that fuel prices should never be employed as a yardstick by which to measure fuel oil value; neither should the Baumé gravity. The source of the oil, its viscosity, carbon residue, entrained water, the sulphur and the ash are all important factors. And finally one should not forget that an oil, even though it meets all the specifications set down by the engine builder, may prove utterly unsuited due to some yet-to-be-discovered characteristic.

In this country there are three chief sources of fuel oil: the California fields, the Mid-Continent and the foreign fields, such as South America and Mexico. The distillates from oils coming from these three fields are distinctly different in behavior, and the engineer who has successively used a Mid-Continent 22-deg. Baumé oil may receive a decided shock when he essays to burn a 28-deg. Baumé distillate from South American crude.

Broadly speaking, however, the two characteristics that determine the suitability of an oil as a diesel fuel

are the "Conradson," (carbon residue) and the viscosity. Viscosity is, of course, a measure of the internal friction of the oil, the ability of particles to slip by each other, but in diesel fuel the viscosity is a measure of the free-flowing characteristics of the oil and incidentally its atomizing behavior.

Tests indicate that the fuel oil must be free-flowing, so that it can fill the small cavities of the pump without gasing and flow through the pipe line and spray nozzle with a minimum of resistance. For most mechanical-injection engines a delivered Saybolt viscosity of 130 sec. or less insures an oil of ample flowing characteristics. If necessary the oil should be heated to give this viscosity. The light distillates show a viscosity below this value at ordinary room temperatures. Heavy oils, ranging from 12 to 24 deg. Baumé must be heated to reach this viscosity.

Heating of oil is by no means expensive, nor does it have any deleterious effect. If the storage tank is outside, as is customary, a hot water coil should be inserted in the tank to insure sufficient fluidity. Otherwise the oil pump may not be able to lift the oil.

The engine fuel pump and the oil lines from the pump to the spray valves should be provided with hot-water jackets. In existing engines it may be impossible to jacket the pump, in which case jacketing the line from the house tank to the pump and the lines to the spray valves will be sufficient.

Either of two heating methods may be followed. An electrical coil heating element may be inserted in the oil line or the oil-line jacket may be heated by hot water. The difficulty of the electrical coil is that the oil temperature cannot be regulated closely and oil may deposit on the coil and fractional distillation occur. Hot water may be obtained cheaply by installing a small waste-heat boiler or by simply inserting a pipe coil in the exhaust muffler or manifold. The water temperature can be regulated to give a uniform oil temperature.

Preheating of the oil to give the proper viscosity is more vital when the engines employ solid injection than when they use air injection. On the former engines the spray nozzles and piping are small; if the oil lines are too large in cross-section, the compression of the oil in the lines may disturb the spray timing. Air-injection engines do not labor under this handicap and the oil lines and spray nozzles are large. Furthermore the air blast does the atomizing, and low viscosity is not so important as it is when the oil is atomized by pump pressure.

If oil burning were dependent only upon the existence of the correct viscosity, no difficulty would be experienced with any oil, for, as has been outlined, the corrective is obtainable at a small expenditure. But the bugaboo, the Conradson residue enters the picture.

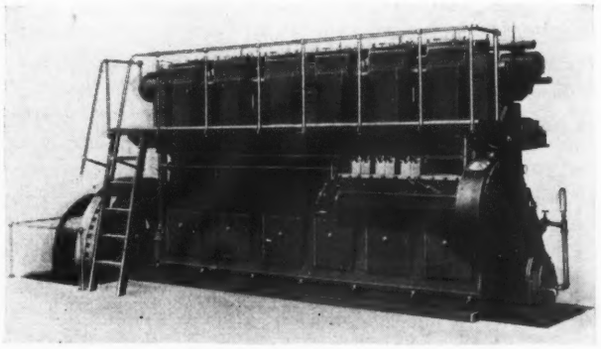
Carbon residue is that portion of the oil that remains after an oil sample has been subjected to heat under atmospheric pressure but away from contact with the atmosphere. It is merely the oil that will not boil away, and its percentage is highly indicative of the value of an oil, or rather of the ability of the engine to burn the fuel.

An oil with a high Conradson residue will cause piston rings to gum tight in the grooves, will cause the valve stems to stick and will score the cylinder liner. The stuck rings and valve stems are due to a tar-like deposit, a part of the oil that is unburnable. The liner wear results from the formation of flint-like oil particles.

Since the spray nozzle will pass but a definite amount of oil per unit of time, obviously if 10 per cent of the oil is carbon residue that is unburnable the engine's maximum load capacity will drop by this per cent. In addition, the carbon may settle upon the spray nozzle in the form of a hollow cone, thereby preventing proper distribution of the oil particles. Finally, the unburned carbon blows out of the exhaust passage, giving a dark color to the exhaust gases.

What the maximum carbon residue should be depends upon the type of engine and the source of the crude oil. One cannot predict the behavior of a new engine design, and the maximum carbon can only be determined after tests.

Slow-speed engines will handle all oil with a much higher carbon content than will high-speed engines. This is not surprising, for the burning of the carbon residue depends upon the time interval. In an engine cylinder



A medium-speed mechanical injection engines needs a fuel of moderate Conradson

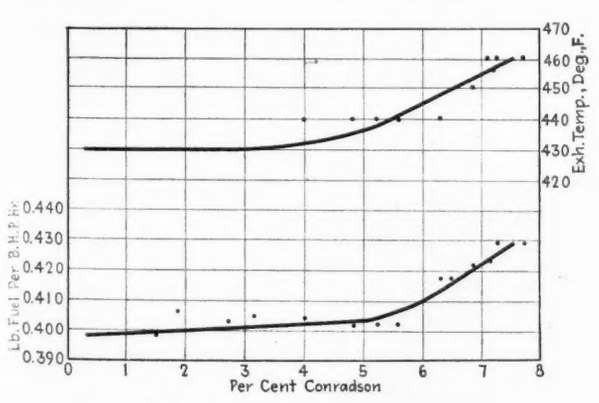


Fig. 1—Relation of carbon content in fuel to consumption when using fuel A

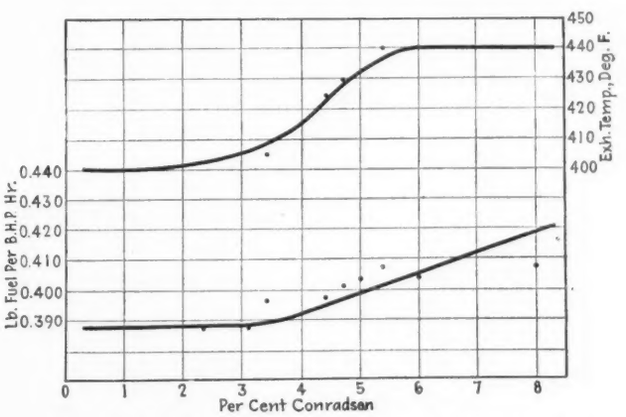


Fig. 2—Relation of carbon content in fuel to consumption when using fuel B

the amount of carbon remaining unburned increases with the revolutions per minute.

Tests have indicated that for an engine operating at 750 to 900 r.p.m., with mechanical injection, the carbon residue should not be over 0.5 per cent. Engines running at 300 to 400 r.p.m. may well burn oil with 1.5 per cent, while engines of 200 to 300 r.p.m. will show ill effects if the residue percentage goes to 5 per cent. Slow-speed air-injection diesels, especially those of the port-scavenging type, can handle a 10 per cent carbon residue fuel.

As has been stated, liner wear increases with the carbon percentage; consequently the cylinder liners will wear out in 5,000 to 15,000 hr. of operation on 10 per cent carbon oil, whereas the liners should have a life of 20,000 to 40,000 hr. when the engine is operated on 5 per cent oil.

As examples of engine behavior indicated by the increase in fuel oil consumption, tests conducted by one engine builder may be cited.

Two different residual oils, *A* and *B*, were mixed in various proportions with the standard test floor fuel oil and tests at 100 per cent load were made of each of these mixtures on a single-cylinder solid-injection engine. Readings were taken of exhaust, cooling water and room temperatures, and of fuel consumption and speed. The general engine operation was also noted.

TABLE I — RESIDUAL OIL SPECIFICATIONS

	Fuel A	Fuel B
Gravity, A.P.I., deg.	12.0	3.6
Flash Cleve. open cup, deg. F.	665	320
Viscosity Furol, at 210 deg. F.	436	325
Carbon residue, per cent	12.79	17.61
100 Pen. asphalt content, per cent	98.42	72.70
Ratio carbon residue to 100 Pen. asphalt	1:7.69	1:4.12

The amounts of each residual oil added to the standard shop oil and the resulting Conradson carbon residue are given in Table II.

TABLE II — MIXTURES USED IN ENGINE TESTS

Asphaltum A Gallons	Standard Fuel Oil, Gallons	Asphaltum by Weight, Per Cent	Gravity, Deg. API	Conradson, Per Cent	Distillate at 700 Deg. F. Per Cent
0	10	0	31.1	0.30	97.0
1	10	10.2	....	1.50	....
2	10	18.5	....	2.71	....
3	10	25.3	....	4.03	....
3.5	10	28.4	....	4.84	....
4.0	10	31.2	....	5.21	....
4.5	10	33.7	24.9	5.59	75.0
5.0	10	36.0	....	6.30	....
5.5	10	38.4	....	6.48	....
6.0	10	40.5	....	6.89	....
6.5	10	42.5	....	7.11	....
7.0	10	44.0	....	7.30	....
7.5	10	46.0	....	7.75	63.0
Asphaltum B					
1	10	10.7	....	2.36	....
1.5	10	15.3	....	3.14	....
2.0	10	19.2	....	3.44	....
2.5	10	23.1	24.7	4.43	82.0
3.0	10	26.5	....	4.74	....
3.5	10	29.6	....	5.40	....
4.0	10	32.5	....	6.00	....
4.5	10	35.0	....	6.72	....
5.0	10	37.6	21.3	8.38	71.0

It will be noted in Figs. 1 and 2 that there was a decided increase in the fuel consumption and exhaust temperature after a 5 per cent Conradson has been reached. There is some difference in the two samples according to the engine operation.

It is obvious from these tests that for the engine in question a Conradson of less than 5 is necessary, for the sharp increase in fuel consumption when the Conradson went above 5 per cent indicates that combustion was poor, the exhaust dark and operation irregular.

On the other hand, the Florida Power & Light Company successfully burns a 10 per cent Conradson oil in slow speed air-injection two-stroke cycle diesels, although at the expense of increased maintenance.

European engine builders are much stricter in their oil specifications than are American builders, and it is the general experience that American engines will handle a poorer grade of fuel.

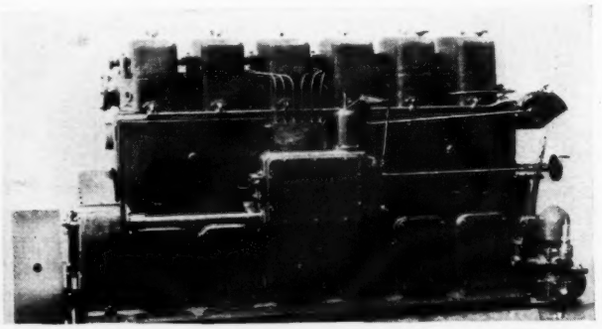
Some European specialists claim that the real factors that determine an oil's suitability are the self-ignition temperature and "ignition factor." The self-ignition temperature is the temperature at which the oil will ignite in a stream of oxygen. To make the test oxygen out of a container under pressure of one atmosphere is passed through an accurately adjustable throttle valve and from it through a bubble counter and drier to a crucible made of a heat-resisting non-flaking steel equipped with three ignition chambers and one thermometer chamber. The crucible is electrically heated and can be brought to any desired temperature. In determining the self-ignition point, that is, the lowest temperature at which ignition will take place in a generous stream of oxygen, a drop of oil is placed in the ignition chamber.

The temperature t in degrees Centigrade divided by the number of oxygen bubbles per minute b plus one, to take care of the oxygen reaching the ignition chamber from the outside air, is taken as the measure of ignitability or ignition factor F; thus

$$F = \frac{t}{b+1}$$

These factors are well worth examination, but until their value is more definitely determined it will be well for engineers to adhere to the Conradson limitations.

The subject cannot be dropped without a word of warning as to the uncertainty of all fuel oils made up of residuals from cracking coils. The crudes may have come from several different fields and when mixed the distillates and residuals may show undreamed of characteristics. At times a car of fuel oil may be received which simply refuses to burn. Just why no one knows—oil refiners mention "aromatics" and "unsaturates," claiming that the pressure of aromatic compounds interfere with combustion. This matter is now being given close study, but no definite results have been obtained.



A high-speed diesel will not burn an oil with more than a minimum of oil residue

Can the Burning of Hog Fuel Be Improved?

A Comparison of Existing Methods

By J. GULICK
Fuel Engineer
Portland, Oregon

Wood refuse has been burned for at least 40 years under water-tube boilers and perhaps twice as long under older types of boilers. Many concerns using such fuel have rather deep-seated ideas as to how it should be burned, for varied are the furnace arrangements that can be seen in any district where wood refuse is available. The author discusses and compares these arrangements from an operating standpoint

WOOD WASTE for steam making, locally known as "hog fuel," has an ash content of not over 1 per cent of the dry weight of the wood, including the bark and the dirt picked up in transit. It is measured by volume, a unit of hog fuel being 200 cu.ft., which will weight from about 3,300 to 4,500 lb., depending on the moisture. The N.E.L.A. standard unit is 3,500 lb., 40 per cent moisture and 12,980,000 B.t.u. available heat value, at 50 per cent excess air supply to the furnace and 500 deg. F. stack. However, a bulletin issued by Oregon State College in September, 1929, titled "A Discussion of the Properties and Economics of Fuels Used in Oregon," by C. E. Thomas and G. D. Keerins, lists twenty-eight samples of hog fuel from the three Pacific Coast states, the moisture content ranging from 34 to 67 per cent, with an average of 46 per cent.

TABLE I—AVERAGE DATA FROM 28 SAMPLES OF LUMBER MILL REFUSE

	Total Weight per Unit Lb.	Moisture Per Cent by Weight	B.t.u. per Lb. Dry	B.t.u. per Lb. in Furnace
Redwood sawdust from sinker logs (highest moisture)	5,850	67	8,961	2,960
Fir-hemlock shavings (lowest moisture)	2,960	34	8,474	5,630
Fir-hemlock, spruce-pine-redwood, cedar hog and sawdust mixed (ave. moisture)	4,100	46	8,700	4,710

The data on these samples are here condensed in Table I, with the weight of the fuel included. It is fairly representative of refuse fuel available on the Pacific Coast.

In the ordinary hog fuel furnace (Fig. 1) the fuel, which is in a cone-shaped pile on a flat grate, tapers off to a thin edge at the grate. With this arrangement the draft picks up the fines and short circuits the major part of the pile. Since the fuel feeding on top of the pile does not start to burn until the surface moisture has evaporated, the main body of the pile is green fuel nearly down to the grate line. That is, only the lower surface of the pile and the circumference on the grates for about 18 to 24 in. inward is burning. It is the writer's opinion that the lower part of the pile in contact with the grates probably accounts for 80 per cent or more of the total burning action of the fuel. If the fuel is very coarse it may be gassing throughout the entire mass, but the general run of fuel contains so much sawdust and other fines that it packs closely enough to prevent air flow through it with ordinary stack draft, whenever the depth is greater than about 18 in. Under these conditions it is probable that some of the moisture is evaporated low down in the pile and reacts with the fuel as it passes through the fire zone. There are several indications of such water gas reaction but no collected data.

Some have contended that hog fuel in a dutch-oven furnace burns mainly on the surface of the cone because of the air supply through the feed hole and that the fuel burned by the air supply through the grates is only incidental. However, the burning action can easily be ascertained by merely closing off the air supply to the grates. As this is the procedure ordinarily followed to reduce the rate of steaming, it is apparent that the under-grate air supply must be very necessary.

Boiler and furnace efficiency with hog fuel varies from 35 to 65 per cent, depending upon the moisture content, with an average of about 50 per cent. The figures in Table II are taken from the results of ten boiler tests on a 4,000-sq.ft. B. & W. boiler showing a range in efficiency from 35.8 to 56.5 per cent.

TABLE II

Test No.	Boiler Rating, Per Cent	Moisture in Fuel, Per Cent	Overall Efficiency, Per Cent	Green Fuel per Sq.Ft. of Grate per Hr., Lb.	* Total Heat Release per Sq.Ft. of Grate per Hr., B.t.u.
5	110	41.6	35.8	83.6	382,000
6	178	35.2	56.5	74.4	384,000

Looking at some of the furnace shapes and arrangements that are in use at the present time, one would get the idea that the fuel reaction must be completely finished in the oven part of the furnace and that only the hot gases should be delivered to the combustion chamber. Of course, in any boiler furnace the fuel should be completely burned before the heating surface is reached, but experience tells us that the most satisfactory procedure is to burn the fuel in sight of the boiler heating surface so as to get the benefit of radiant heat.

The layout shown by Fig. 1 is accepted as good practice for water-tube boilers, but the furnace maintenance is high, while the over-all efficiency is low. The large excess air supply through the feed hole rushes downward over the fuel pile and reacts with the hot raw combustible gas flowing up out of the pile, with the result that combustion is practically complete at *A*. Red hot cinders accumulate at *C* and do not burn away unless air is supplied through the bottom of the mud drum wall. It is common to observe green sawdust on the surface of this cinder pile where the furnace is improperly proportioned to the driving rate of the unit. At *D* is another cinder pile consisting largely of carbonized sawdust, such as goes out of the stack. These stack cinders exhibit the peculiarity of dampness, which may be due to the fact that wood is a thermal insulator and the raw dust particles carried in suspension by the hot gases quickly dry out on the surface and start burning while the center is still moist.

Wood ash has a fusing temperature of about 2,200 deg. F. If the temperature in the combustion chamber exceeds this, as may be the case where oil supplements the wood fuel (see Fig. 5), the fly ash melts and runs down, cutting grooves in the face of the walls. This fluxing action on the brick may be assisted by the steam content of the gases if the temperature is high enough. Thus furnace maintenance is likely to be high.

Burning On Inclined Grate

During the past ten years the inclined grate, Fig. 2, has been employed in a number of installations. In a few cases it has been discarded because the small quantity of ash from wood fuel offers little heat protection to the cast-iron steps of the grate and at some rates of driving the step bar maintenance becomes excessive. However, an inclined grate equalizes the air flow through the fuel bed, which is an improvement over the cone pile on a flat grate, as detailed by Fig. 3, which is the ordinary dutch-oven furnace arrangement for horizontal return-tubular boilers. In this layout the corners *A* of the grate, are bare and small lazy flames burn downward through the grate in the ashpit.

In Fig. 2 the fuel burns away much faster along the side walls at *E-E* than in the main fuel body *D*. Also, the fuel supply to the furnace is seldom constant, so that occasionally cold air rushes into the furnace over the burning fuel the full length of the feed opening, which is the entire width of the furnace. Ordinarily little or no air comes in with the fuel, hence the fuel bed must be thin enough to pass all the air required for combustion. The result is that the highest temperature is developed at *A*, where it serves no direct purpose in making steam so far as radiant heat transfer is concerned. Neither does it serve as a first-class ignition arrangement for the green fuel coming under the feed gate, due to the acute angle formed by the arch and the fuel pile plus the interference to radiant heat transfer from the arch nose because of smoke formation.

It is generally considered that large arch surface and drop-nose mixing arrangements are necessary to burn 50 per cent moisture hog fuel, but it should be further realized that a deep bed of burning wet fuel between the side walls will make a lot of fire without an arch roof of any kind. Also, if the draft pressure is sufficient, the surface of the fuel pile requires no reflected heat to expedite the rate of fuel burning. It is easy to visualize such an arrangement but it would make a lot of smoke. The thick smoky gas from the deep fuel bed is raw producer gas having a hydrogen content somewhat less than that of carbon monoxide. The hydrogen is due to the water-gas reaction in the bottom of the fuel bed.

Means For Reducing Stack Temperature

The moisture represents a large heat loss up the stack, which is further increased by the high stack temperature generally found where the boiler operation is above 100 per cent rating—700 to 800 deg. is quite ordinary. This indicates that little work is done by radiant heat transfer in the first pass. The layout of Fig. 4 would reduce the stack temperature by increasing the radiation transfer in the first pass. This hearth-type producer furnace would cost no more than the incline-grate furnace of Fig. 2, while the boiler performance would be better on the score of driving rate, efficiency and the smoke and cinder conditions. The deep fuel bed would require more fuel in the furnace than the inclined grate of the straight dutch-oven furnace. This increased fuel volume is a disadvantage, for it requires too much time to burn the furnace down at clean-out periods.

Especially is this true for industrial work, where the end of the work day requires that all fuel bed drafts be closed off tightly on a furnace full of fuel or else permit the safety valves to blow, a practice that is quite common in sawmill work. However, with all furnace drafts closed off the furnace soaks up the residual heat of the large fuel bed and the expansion stresses tend to loosen the brickwork. On the other hand, this furnace arrangement has interesting features: The primary air supply from *C* goes through the fuel bed along the lines *D* at about 45 deg., which angle prevents pipe action or blowholes in the fuel bed such as invariably occur where the primary air flow is vertical. Secondary air is supplied by a row of nozzles in the arch at *B*, which drives the air and combustible gas downward and develops the highest temperature zone at *A* which is effective over the entire length of the front row of tubes.

The jet action of secondary air downward from the top of the furnace has some advantages for combustion as compared to the entrance of secondary air at any other place, if the average temperature in the combustion chamber *A* is around 2,000 deg. F. and the secondary air temperature around 100 deg. F. The latter being practically four and one-half times as heavy as the combustion chamber atmosphere. However, the secondary fuel reaction functions much better moving downward than moving upward, also the heat flow from the flame to the boiler is from a much greater area than the localized hot spots of the combustion chamber.

Since the flat-arch furnace roof came into general use many installations have been made in the Pacific Northwest with the furnace arrangement shown by Figs. 5 and 6. The over-all cost of such layouts is high and

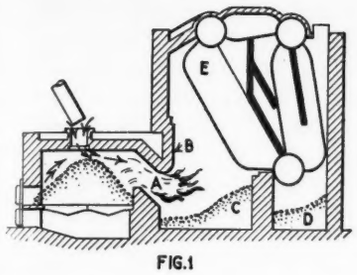


FIG.1

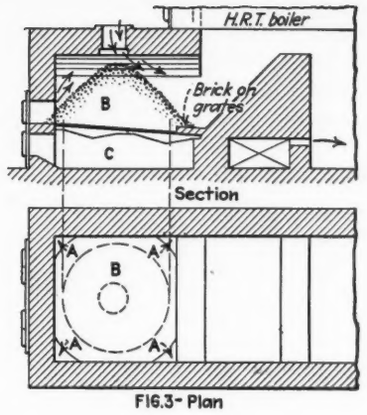


FIG.3- Plan

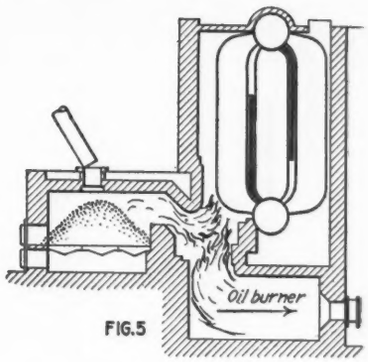
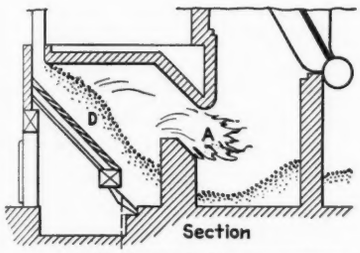


FIG.5



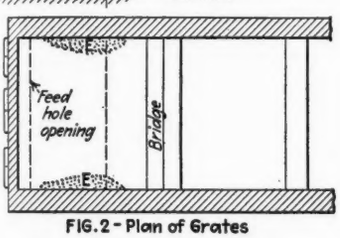


FIG.2 - Plan of Grates

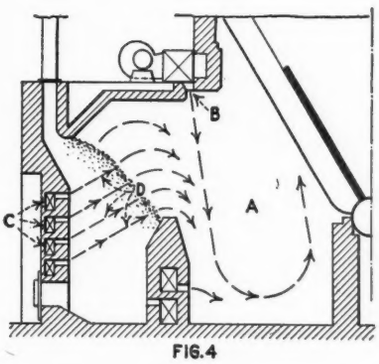


FIG.4

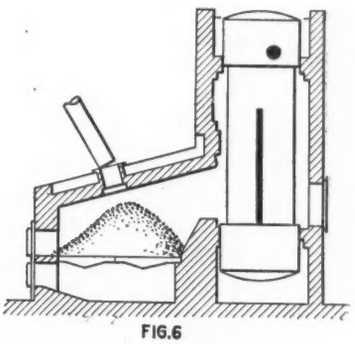


FIG.6

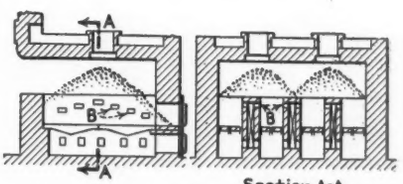


FIG.11

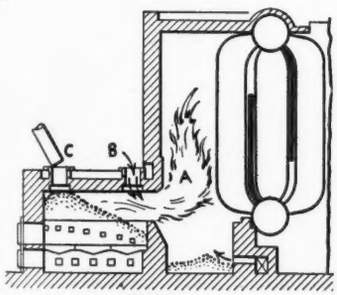


FIG.7

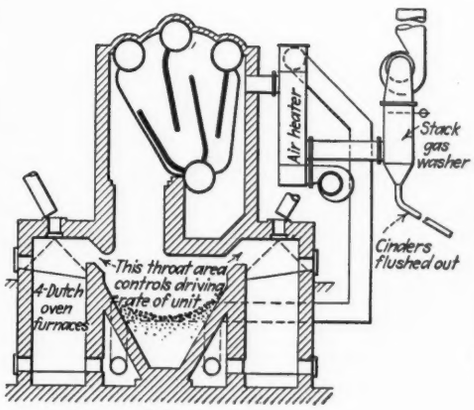


FIG.9

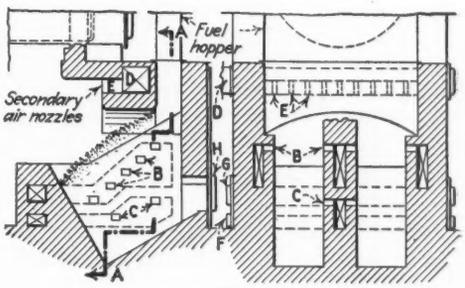


FIG. 12

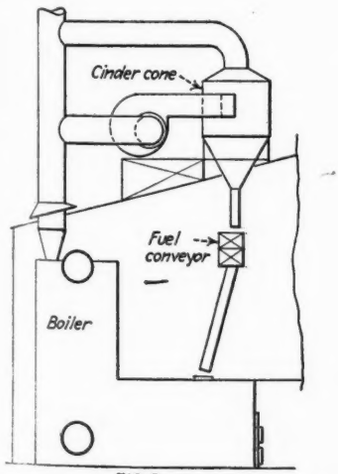


FIG.8

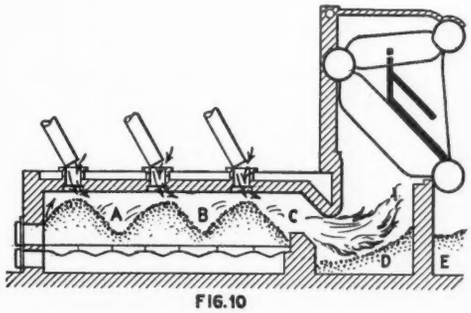


FIG.10

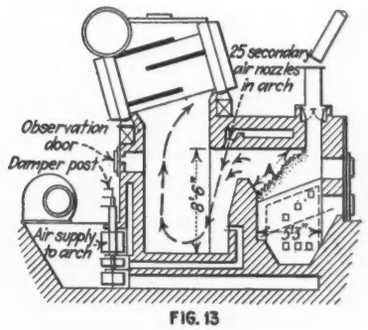


FIG. 13

SECTIONS OF VARIOUS FORMS OF FURNACES FOR BURNING HOG FUEL

brickwork maintenance excessive. Fig. 5 is laid out to burn fuel oil under the mud drum, and it is common practice to burn both fuels at the same time. It is also common to find a temperature approaching 3,000 deg. F., in the oil furnace with the unit operating at less than 150 per cent rating, under which conditions it is obvious that the over-all efficiency must be poor.

The arrangement of Fig. 7 incorporates several advantages over Fig. 5. The efficiency and the ratings are both higher, while brickwork maintenance is lower and smoke and cinder conditions are improved. A short distance south of Portland, Ore, a unit of 6,000 sq.ft. in a paper mill having the arrangement shown by Fig. 5 is exactly matched by a similar unit having the furnace arrangement of Fig. 7 in a lumber mill. The two boiler houses are about 400 ft. apart. The setting of Fig. 7 develops 300 per cent rating with little smoke or cinders, while that of Fig. 5 develops 150 per cent rating with considerable smoke and excessive cinders, although at present the boiler house of the paper mill is equipped with cinder cones.

Returns Cinders to Furnace

In Fig. 8 the dust spout of the cinder cone discharges into the hog fuel conveyor to carry the cinders back to the furnace. This procedure does not work very well, for the cinders do not seem to burn the second time in the furnace. Just why this is so is not exactly clear. However, the alternate procedure is to sluice the cinders out to the ash dump. At best the cinder cone is a makeshift.

A power company in Portland, Ore., has tackled the cinder and smoke problem from a different angle, as shown by the arrangement of Fig. 9. Here the stack gas is drenched by a rain-type washer which removes cinders and smoke and by means of an air preheater recovers a large part of the stack gas heat.

A lumber mill in California has a furnace arrangement such as shown in Fig. 10 under an 11,000-sq.ft. bent-tube boiler. This furnace was laid out to operate the boiler at 300 per cent rating. In the furnace arch there are six feed holes in two rows. Point *A* is representative of about the same condition as at *A* in Fig. 1, that is, the combustion is practically complete. Also, at *B* the combustion is practically the same as at *A* except that the gas volume is greater, but at *C* the cumulative temperature and gas volume develop such severe erosive action on the bridge wall throat section that the furnace walls give only short service and the base of the combustion chamber at *D* and under the mud drum at *E* fills up with red hot cinders.

Pier-type of Furnace for Low-grades of Hog Fuel

About 1925 a furnace builder in Portland developed what is known as the pier furnace for burning hog fuel, especially poor grades that have weathered a year or more in the storage pile and also the refuse from those mills cutting large quantities of spruce and hemlock. The pier furnace consists of a hollow wall through the center of the furnace about as high as the bridge wall, as shown by Fig. 11. This hollow wall has a number of air ports which introduce air up into the body of fuel, in a region where otherwise there is no air supply and consequently no combustion. This pier arrangement is used in the furnace shown in Fig. 7, where the fuel is run into the furnace clear up to the feed hole, so that practically no secondary air enters at this point. Only air is permitted to enter at *B* and the flame starts at this point, carrying well out into the combustion chamber and half way up the tube bank.

The placement of the air ports, *B*, Fig. 11, and *B*, Fig. 12, represents considerable experience. If they are too low the net result is little better than the amount of grate surface displaced by the pier, while if they are too high or close to the surface of the fuel pile they short circuit the air supply from the grates; also if the individual port area is less than about 3 sq.in. there is a tendency to slagging over, which shuts off the air supply entirely. The nozzle blocks or the brickwork that forms the nozzles must be No. 1 firebrick, as no other grade of refractory will stand up to the severe temperature conditions of the fuel bed in front of these air ports.

The width of the fuel space between the piers need not be more than 24 to 36 in., while the height of the piers should be not less than about 30 in. above the grate line; 48 in. would be better. This pier arrangement works as satisfactorily without grates as with them, in fact where the construction supervision is good the furnace performance will be better after the grates are removed, provided the fuel supply is constant.

Producer-gas Type of Furnace

The pier-type furnace of Fig. 12 shows an arrangement without grates that will burn considerably more fuel than the same over-all size of furnace with grates. This layout is a form of producer-gas furnace rebuilt into what was originally a straight dutch oven with flat grates.

Positive air supply at about 2-in. pressure is required in the air duct *D* to supply the secondary air nozzles *E*. Also, positive air supply at about 1-in. pressure is required in the bridge wall air duct *G* to supply the primary air to the ports *B* in the pier and side walls. The air ports *C*, supplied by the air duct *F*, are to burn the fuel down at clean-out periods. The fuel hopper is the entire width of the furnace and extends up about 4 ft. above the deck line to provide a head of fuel on the feed opening to blank off air leakage inward. At this point, the ashpit doors *G* must be practically gas-tight.

In a furnace layout of this kind the rate of air supply to the secondary air nozzles *E* controls the operation, and if the fuel supply is constant a boiler pressure damper regulator connected to the air supply ducts *D* and *G* will make the furnace performance automatic. This type of furnace is smokeless, and also cinderless up to some rate of driving. A furnace having an arch span of 6 ft. wide by about 6 ft. long will evaporate 12,000 lb. per hour before the stack throws out cinders.

Another example of producer-gas type furnace which has interesting features is the layout of Fig. 13. This installation was put up in 1927 by a food packing company in Oregon. The unit is a marine-type boiler of about 2,500 sq.ft. of heating surface, 13 ft. wide over the waterlegs, which figure is also the inside width of the combustion chamber. The unit operates at 200 per cent rating with about 1 in. air pressure in the secondary air nozzles in the arch. The temperature in the furnace above the fuel bed at *A* is less than 1,400 deg. F. under normal operating conditions, but if the fuel supply in the feed hopper gets down low enough to let air slip in through the feed hole the furnace temperature immediately starts to rise, while the temperature of the combustion chamber goes down. In normal operation

the combustion chamber is much hotter than the upper part of the furnace.

This unit has air-cooled walls. The secondary air flows from the control damper at the center of the rear wall both ways horizontally to the side walls, and along each side wall to the feed hole line, then up to and across the arch to the arch nozzles. There are two separate furnaces 60 in. wide by 63 in. long, and each furnace has a pier. All primary air is supplied by the air ports in the piers only, the furnace side walls being blank. The flame which starts at each secondary air nozzle in the arch travels downward in a rather unhurried fashion to the bottom of the combustion chamber and half way across the floor before the gas reaction is complete. Each air nozzle can be identified on the combustion chamber floor by its respective tongue of flame. The secondary air nozzles are 6 in. apart.

In the two-step fuel reaction obtaining in the producer-gas type of furnace only part of the total air goes through the fuel bed and over the bridge wall, the rest being supplied at the arch nozzles as secondary air. Whatever surplus air is required also goes through the secondary nozzles. This means that the fuel bed can deliver about twice the heat value to the combustion chamber for the same velocity gas flow as in the ordinary dutch-oven furnace. In other words, the producer gas type of furnace can burn twice as much fuel as the same overall size dutch-oven furnace, but to do this requires an air pressure greater than the natural draft available in the ordinary boiler stack.

When the layout of Fig. 13 was built the question came up as to means for cinder removal from the bottom of the combustion chamber which has no clean out door in the lower part of the setting. After about thirty days operation it was noted that a slight increase of excess air would burn out the bottom cinders in a short time. As this unit was originally equipped with grates, it was necessary that the grates be cleaned every other day, but after the grates were removed the unit operated five weeks before the ash and clinker had to be removed from the ashpits.

Refuse furnaces are attached to practically every type of steam boiler built but there are many installations where the boiler is not well proportioned to the characteristics of the fuel, and for those concerns that must use hog fuel there is plenty of room for improvement in the many details of refuse burning equipment.

Specification for Fuel Oil From Cracked Residue

THE PRICE and quality of fuel oil available for the needs of power engineers is continually being affected by new developments in the refining industry. An example is the Goodwin Process, marketed by the Dorr Company, for the production of specification fuel oil from crackingstill residua.

Solid carbon and other particles in the residual oil from the usual cracking processes are extremely fine and will not all precipitate out even after many days of settling. These solids are undesirable in fuel oil and cause storage and burning troubles.

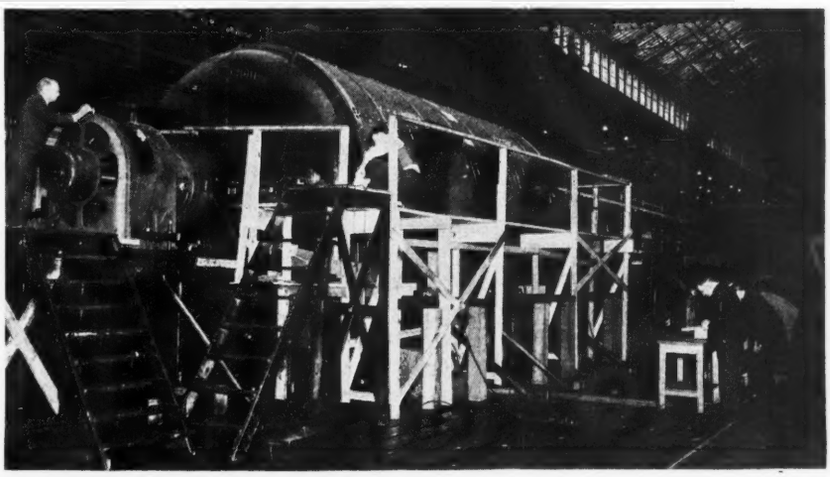
It is unnecessary to outline the technical details of the process, which are of interest only to refiners. It may be pointed out, however, that the residuum is mixed with sulphuric acid in such a way as to cause the precipitated and potential carbon to flocculate and that the flocculated carbon is then separated by gravity in a thickener or by direct filtration in a suitable filter.

▼

Special Tests Made on Largest Self-Cooled Turbine Generator

THE largest self-cooled turbine-generator is undergoing many unusual tests at the East Pittsburgh works of the Westinghouse Electric & Manufacturing Company before shipment to the Public Service of New Jersey. It is rated at 100,000 kva., 13.8 kv., at 1,800 revolutions per minute.

As part of the special tests, stray-load losses in the unit are being measured directly, both for magnitude and distribution. Under sudden load changes machine parts soak up heat so rapidly that there is no temperature rise for a moment. The flow of heat from machine parts does not change instantly and the initial rate of change of temperature is a function of the change in heat input and the specific heat of the material. Simultaneously measuring the amount of heat stored up in various parts at extremely short time intervals gives a set of curves from whose slopes can be figured watts-per-pound loss.



A 100,000-kva., 13,800-volt, 1,800-r.p.m. generator under test to determine the stray-load losses.

DESIGN VS. OPERATION AT THE HOTEL NEW YORKER

By WARREN D. LEWIS
Chief Engineer
Hotel New Yorker

Completing the story initiated in the May 3 issue of Power, the author here compares the actual electrical loads of the Hotel New Yorker, based on one year's operation, with the advance estimates. Variations greater than with low-pressure steam are noted, along with their primary cause — refrigerating load of the air conditioning system.

PART II—THE ELECTRICAL LOAD

THIS ARTICLE concludes the story started in the May 3 issue of *Power*. In the latter the actual low-pressure steam consumption and available exhaust in the Hotel New Yorker, New York City (based on one year's operation) were compared with three different sets of preliminary estimates. Some of these estimates were remarkably close to the actualities. Others differed substantially.

In this second and concluding article the actual electrical load will be likewise compared with the original estimates. The total actual electrical production by both steam and diesel units for the year 1931 totaled 8,822,510 kw.-hr. Deduction of 275,810 kw.-hr. supplied to concessions leaves 8,546,700 kw.-hr. as the total consumption of the hotel.

Following the plan of the first article, the actual and estimated results will be designated as follows:

1. *"Actual"*—Results obtained for the year 1931, unless otherwise stated.
2. *"Power"*—Estimates made by Messrs. Swain and Morrison, associate editors of *Power*, in the Nov. 26, 1929, number of *Power*.
3. *"Utility"*—Estimates submitted by the New York Edison Company, summarized in *Power*, Nov. 26, 1929.
4. *"Engineers"*—Estimates of the hotel's designing engineers, working with the engineers of the Skinner Engine Company, also summarized in *Power*, Nov. 26, 1929.

A comparison of the total electrical requirements of the hotel as forecast before opening, with the actual electrical output of 1931, is given in Table I.

TABLE I — ELECTRICAL ENERGY CONSUMPTION FOR 1931, KILOWATT-HOURS

		Difference	Per Cent Error
1. *Actual*	8,546,000	.....	.....
2. *Power*	7,500,000	1,046,000	12.3 low
3. *Utility*	5,045,000	3,501,000	40.9 low
4. *Engineers*	6,766,200	1,780,800	20.9 low

The comparison reveals at once that all estimates were too conservative. The *Utility* is benefited more by a low result, as the unit cost will be consequently higher and make it more easy to justify central-station current. Likewise, the *Engineers*, especially those of the engine company, are benefited by the higher estimates they gave, and still more by the actual results obtained.

Refrigerating Load Affects July Estimates

In seeking the reason for the discrepencies, it might be well to compare the winter and summer seasons. With this in view note a comparison of January and July electrical outputs is given in Tables II and III.

TABLE II — JANUARY — KW.-HR. GENERATED

		Difference	Per Cent Error
1. *Actual*	659,350	.....	....
2. *Power*	690,000	40,650	6.2 high
3. *Utility*	538,125	121,225	18.4 low
4. *Engineers*	563,850	95,500	14.5 low

TABLE III — JULY — KW.-HR. GENERATED

		Difference	Per Cent Error
1. *Actual*	874,830	.....	....
2. *Power*	644,800	230,030	26.3 low
3. *Utility*	316,042	558,788	63.9 low
4. *Engineers*	563,850	310,980	35.5 low

The figures for January speak for themselves. The greater error in the July estimates is undoubtedly due to the unexpectedly large refrigeration load of the air-conditioning equipment. The use and consequent load placed upon this apparatus was considerably higher than the designers themselves anticipated.

Air-Conditioning System Enlarged

It was found advisable to increase the capacity of the air-conditioning system in the spring of 1931. In this connection an extra centrifugal pump (driven by a 50-hp. motor) and other equipment were added. This has added approximately 700 kw.-hr. daily load during the summer months, but no allowance has been made for this in the comparisons. Only the actual kilowatt-hour consumption. Table IV repeats the comparison of Tables II and III, but on a daily basis.

TABLE IV — AVERAGE DAILY GENERATION, KW.-HR.

	January	Difference
1. *Actual*	21,270	.....
2. *Power*	22,260	990 high
3. *Utility*	17,360	3,910 low
4. *Engineers*	18,190	3,080 low
	July	
1. *Actual*	28,220	.....
2. *Power*	20,800	7,420 low
3. *Utility*	10,200	18,020 low
4. *Engineers*	18,190	10,030 low

Summer Load Highest

The figures of the average daily load in Table IV are a more usable comparison, as they represent more nearly what the operating engineer uses in his daily work. It would seem that the estimators made the usual assumption that, due to the increased lighting load, the electrical demand would naturally be heavier in the winter months. This might possibly be true if there were no air conditioning to consider. However, of the total electricity generated, 28.5 per cent was used for light and 71.5 per cent for power in the month of July, 1931.

TABLE V — COMPARISON OF WEEKDAY AND SUNDAY LOADS, KW.-HR. PER DAY

	January	
Weekdays	21,600	
Sundays	18,550	
Difference	3,050	or 14.1 per cent variation
	July	
Weekdays	29,600	
Sundays	23,800	
Difference	5,800	or 19.6 per cent variation

Air conditioning again causes a larger variation between Sunday and weekday loads.

Power Auxiliaries Take 7.5 Per Cent

Another item which did not get very much consideration is the electrical load in the engine room and boiler room. The *Utility* considered this load, but no other estimates were made available.

The actual electrical energy (Table VI) used by the power plant is approximately 7.5 per cent of the total generated, an amount well worth considering.

As mentioned in a previous article, "heat balance," or more properly speaking, "low pressure steam balance," was not the determining factor in deciding whether or not to operate the diesel generating unit regularly with the steam-engine generators in the off-heating season. As a matter of fact the diesel engine has not been so operated even when exhaust was being wasted to atmosphere.

The fact that no breakdown electrical connection with the public utility was provided made it imperative that the diesel unit be kept in first-class condition as a stand-by. For safety its use was limited to emergencies. I might add that it has on several occasions "saved the day," especially during the first few months after the hotel opened and before all the component parts of the plant were functioning as they should.

Why Diesel Is Not Operated

Possibly, if the preceeding was the only reason for *not* using the diesel, it would have been overlooked many times. However, this non-use was generally justified on a simple basis of dollars and cents. Let me explain: The hotel had been open only a short time (after Jan. 2, 1930) when a check on the use of city water showed that changes were needed to prevent its waste. As originally laid out, the four basements and first four floors were supplied directly from the city mains. Water for the remainder of the building, namely the fifth floor and up, was supplied by tanks on three different levels. These, in turn, were supplied by pumps using a common suction tank in the fourth basement. The suction tank supply was from two sources: first, directly from the city mains through ball cocks; second, city water passing through the CO_2 condensers and discharged into the suction tanks.

TABLE VI — YEARLY ELECTRICAL CONSUMPTION OF BOILER ROOM AND ENGINE ROOM, KW.-HR.

3. *Utility*		
	Pulverizers	170,000
	Ventilation	200,000
	Total	370,000
1. *Actual*		
	Pulverizers	290,000
	Boiler feed pump	124,000
	Ash collector	7,500
	Ventilation boiler room	164,000
	Ventilation engine room	70,000
	Total	655,500

Now this condenser water, with only a winter load on the refrigerating equipment and no air conditioning load, was more than enough for the guest-room requirements. Considering the fact that the laundry, kitchen and boiler room were in the basements and fed directly from the city mains, a piping change was obviously needed. This was made and the supply for these services was taken from the low-level house tank. As the requirements for laundry, kitchen and boiler room amounted to about $30 worth of water a day this change was well worth while.

While this eliminates waste in cold weather, the air-conditioning refrigeration load gives an excess of condensing water, so that in the summer waste exists most of the time. This means that if we run the diesel, when it logically would be needed to reduce the waste of exhaust steam, all the jacket water must be wasted to the sewer and the kilowatt-hour output charged accordingly.

Our records show that in cold weather the daily average building requirements are approximately 60,000 cu.ft. of water. This includes boiler make up, laundry and kitchen, as well as the guest room and other uses. In the summer the refrigerating load, including air conditioning is about 250 tons per 24 hours.

The design called for a maximum condenser water discharge temperature of 72 deg. With inlet water as high as 68 deg. in hot weather, only a 4-deg. range remains. This would require so much condenser water that a minimum of 10-deg. rise was established. Based on a ton of refrigeration requiring the extracting of 288,000 B.t.u.

$288{,}000 \times 250$ tons $= 72{,}000{,}000$ B.t.u. per 24 hr., and with a 10-deg. rise

$$\frac{72{,}000{,}000}{10} = 7{,}200{,}000 \text{ lb. of water}$$

$= 115{,}000$ cu.ft. of condensing water per day, costing $115.

As part of this water is used in the guest rooms, we would have 78-deg. water for "cold" baths when the

water taken from the city mains is at its maximum temperature. To use this 78-deg. water for cooling purposes in the diesel and then use it throughout the hotel is therefore not feasible. This means extra water if the diesel is operated.

If this condition had been anticipated and tank storage for surplus condenser water (including complicated systems of piping to cover this) had been installed, the problem could possibly have been solved, but that is a question of design, and not a simple one either.

The original idea was to recover the heat of the jacket water and engine exhaust by passing the cooling water through the cylinder water jacket and a heat exchanger in the exhaust line. This heated water was to be pumped into the hot-water system for building use or into the open feed-water heaters for the boiler feed. Here again, with a surplus of exhaust steam, the heat recovery is not needed and the additional water will only be wasted to the sewer on account of the surplus from the refrigerating plant condensers.

Power Cost With Cooling-Water Allowance

The diesel unit is of 350-kw. capacity, or capable of generating 8,400 kw.-hr. per 24-hour day if operated at its rated load. It requires 10,000 gal. of jacket water per hour, or 240,000 gal. per day under these conditions. On a basis of 7½ gal. per cubic foot the daily water requirements are 32,000 cu.ft., costing $32.

Comparing costs of 8,400 kw. generated by the steam engines and the diesel unit on the basis of the coal cost of steam (25.2 cents per 1,000 lb.) a uniflow-engine steam rate of 28 lb. per kilowatt-hour, diesel oil costing 6 cents per gallon and 10 kw.-hr. generated per gallon of diesel oil, we get a fuel cost of $59.27 with the steam engines and $50.40 with the diesel.

Here we have a daily fuel saving by using the diesel of $8.87, which is turned into a loss of $23.13 per day due to the necessary wastage of the jacket water.

Alternative Suggestions

The preceding explanation is not given to discredit the diesel engine but simply to explain its present non-use under the special conditions found in the New Yorker Hotel.

Two courses can be pursued to overcome the excessive waste of water and both have been considered. First, the use of a cooling tower would eliminate the water loss, as the surplus from the condensers of the refrigerating plant would be available for makeup. Second, an artesian well would be the ideal solution, but investigation did not encourage the drilling of such a well at present. There are other reasons (mostly economic) why this particular subject was not investigated further.

In reviewing the entire electrical problem of the hotel it would seem that there have been no hotels built sufficiently like the New Yorker to serve as a basis for its design. The divergence in electric requirements is far greater than that in steam requirements. Few if any of the older hotels have the electric equipment comparable with that in the New Yorker. In the kitchen and dining room pantries are electric toasters, waffle irons and griddles. In both the bread and pastry bakeries are large electric ovens. All machinery in the laundry is motor-driven. The power plant is equipped entirely with motor-driven auxiliaries. In addition, the air conditioning installation was a new departure in the hotel field and few realized how much it would be used.

A Basis for Hotel Design

The modern hotel has undoubtedly outgrown the standard methods of design for such buildings. In the distant past a hotel consisted of a certain number of bedrooms, with dining room, kitchen and possibly a laundry to match—but no more. Gradually the hotel has changed until it does not cater to its rooming guests alone. In fact, the banquet halls, ball rooms and large dining rooms (all extensively used by the public), as well as the varied extra services of circulating ice water, bath rooms with all guest rooms, air conditioning in all public rooms, etc., have presented a new problem for the designer.

In "The Ingredients of Heat Balance" (*Power*, Nov. 27, 1929) Mr. Swain referred thus to a paper by the Heating Research committee in the 1923 proceedings of the National District Heating Association: "The authors have there made public an ingenious method for apportioning the yearly demand for steam and electricity by months and by hours for hotels."

As mentioned in a previous article the calculations for steam requirements in a hotel on the basis of over-all factors should be a fairly simple matter. The electrical requirements, however, present certain difficulties for comparative purposes unless the hotel is "cut up," so to speak, into various units such as guest rooms, ball rooms, dining rooms and kitchens, laundry, etc. Possibly by comparing various hotels along these lines some basic design data of value would be obtained. However, it is not the purpose of this paper to go into these details of design.

Altogether I think the designers did a good job in their estimates and have pointed the way to future progress. Undoubtedly, the electrified and air-conditioned hotel of the future will be a much simpler task for the designer and perhaps a less expensive establishment for the management to operate.

Controlling Room Temperature Within One-Thousandth Degree

By B. F. RANDEL
Mechanical Engineer
Navy Public Works, San Diego, Calif.

AN UNUSUAL problem in heating and cooling was recently presented in connection with the design of an optical laboratory. All parts of the building must be maintained at constant temperature for 24 hours of the day during several summer and winter seasons, the temperature desired being 80 degrees.

During certain periods each day when optical measurements are made two men only will be present in the building and most exacting temperature is required. In fact the opticians asked that the temperature be maintained within one thousandth degree. Of course, during the testing period all unnecessary internal sources of heat and air currents will be eliminated.

The laboratory will be approximately 160 ft. by 50 ft. by 40 ft. high. It will be without windows and entrance will be provided through a suitable airlock. Local ventilation to the point of activity will be provided, which ventilation will be stopped during the critical period.

The scheme suggested calls for panel heating of walls, floor and ceiling, using water as the medium. The coils will be backed up against insulating material secured to the concrete walls and ceiling. In front of these coils removable steel plates will be secured. The coils in the floor will be imbedded in concrete, below which a subbase of insulating concrete is placed.

The entire space will be surrounded with a number of pipe coils, in walls and ceiling, behind steel plates and in the floor embedded in the concrete.

A definite amount of water will be constantly circulated through these panel coils, maintaining all surfaces at a constant temperature. The demand for heating and cooling is automatically controlled by regulating the temperature of the water and not the magnitude of flow. Control valves on each panel are set during the testing and adjusting period to maintain the temperature even in all panels.

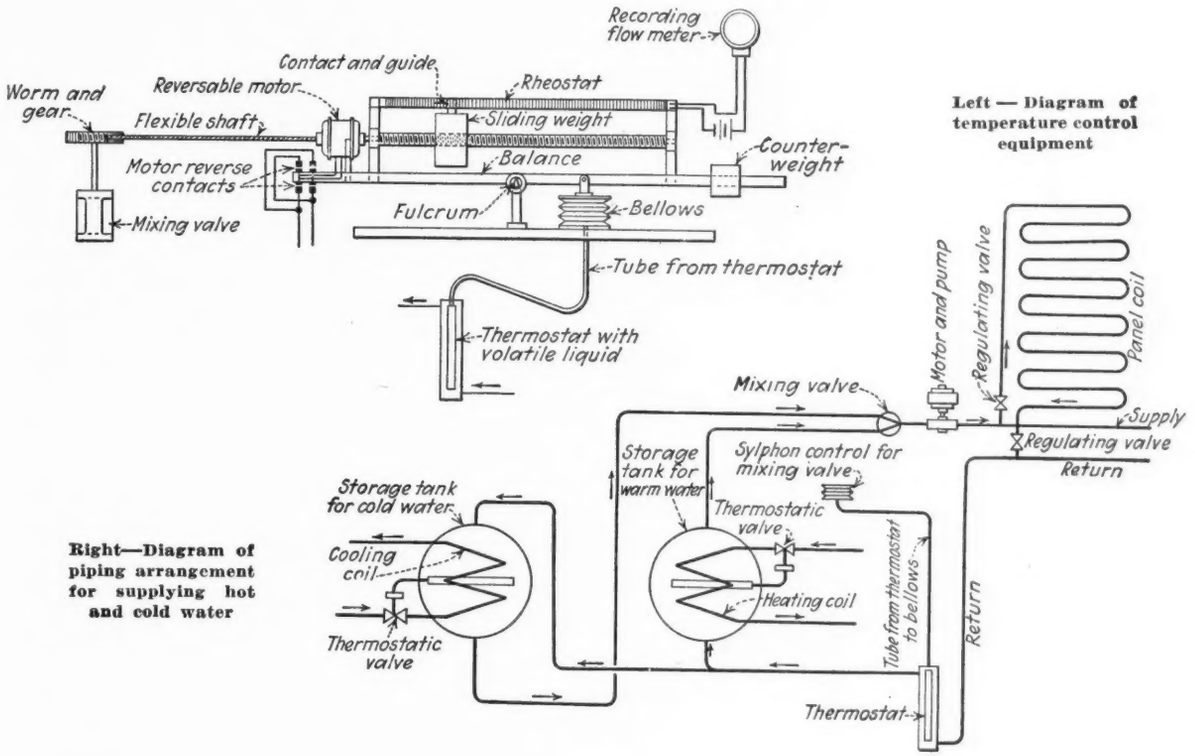
The roof of the building will serve as a water reservoir, the temperature of the water being maintained by sprays. The climate of the locality where the building is to be erected being mild, freezing will not occur and a great amount of heating will not be required. The water on the roof will prevent heat from entering during the summer months.

Two sources of water will be provided, one warm, maintained at a constant temperature by a conventional thermostatic valve on a heating coil, and one cold, also with a thermostatic temperature control on a cooling coil. A refrigerating machine will, of course, be required to provide the cooling.

The warm and cold water will be mixed in required proportions in a mixing valve, a three-way cock of special design, operated by worm and gear.

The control mechanism devised is actuated by the varying drop or rise in temperature in return line as shown. If the temperature in the return drops below a desired point, the mixing valve will open up the warm flow and close down the same amount on the cold flow, and if the temperature rises, the action will be opposite.

The mixing valve operating device consists of a balance controlled by a bellows, which in turn is actuated by a thermostat in the return line. A variation in return temperature will cause unbalance one way or the other. The unbalancing will start a reversible motor attached to a screw operating a weight in a horizontal direction. The moving of this weight will restore the balanced posi-



Left — Diagram of temperature control equipment

Right—Diagram of piping arrangement for supplying hot and cold water

tion, and thus the position of this weight and with it the number of revolutions of the motor will be a function of the temperature in the return line. The motor is attached to the mixing valve with a flexible shaft to allow substantially free motion of the balance, and thus the operation of this mixing valve will be dependent upon requirements as indicated in the returns.

It may be an advantage to use this device to record the flow or the position of the balance weight. This may be done by arranging two bars wound as rheostats, between which slides a guide with proper contact points. The lengthening or shortening of the resistance wire will be indicated on a voltmeter, which may be built specially for recording or showing the position of the weight, and thus the valve.

The installation as proposed and outlined will, of course, cost more than ordinary installations. In this case the exact requirements will warrant the additional expense. In other cases the general scheme may be followed, eliminating some of the more expensive features.

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Changes in Control Wiring May Lead to Serious Trouble

By MARIN PHILLIPS

VERY OFTEN occasions arise where it is desirable to make changes in the connections of electrical equipment, other than that furnished by the manufacturer, to adapt the apparatus for operation on another class of service. When contemplating changes in electrical connections a careful study of its operations is necessary, after the changeover is made, to see what effect it will have on the reliable operation of the apparatus. Even then, in some cases, important reasons why the change should not be made may not be discovered until it is too late. A few examples showing the difficulties experienced through changing electrical connections will be cited to show that it is sometimes expensive to make the change.

A relay panel was received from the manufacturer all wired up. It was to be used with a 15,000-volt main-feeder oil switch supplying power for the plant through a bank of transformers. The man in charge of the construction rewired the relay panel to give it, as he thought, a better appearance. The plant's power supply was purchased from the local power company, but the oil switch and transformers belonged to the plant. The power company tested the customer's lines to see that they were adequately protected to prevent disturbances on the power system, in case of plant trouble. To insure this policy being complied with, they tested all relays and tripping devices on the main feeder oil switch, and made a high-voltage test on all insulators before connecting the power service. Upon testing this particular relay installation they found that changes made in the relay panel wiring had made them inoperative under certain conditions often experienced in service. The result was that the relay panel had to be rewired to its original connections.

There were three drum controllers for the operation of a crane. One for the trolley, one for the bridge and one for hoisting and lowering the load. When wiring the motors the hoisting motor was so connected that the controller handle had to be operated in the opposite direction to that shown on the wiring diagram when raising or lowering the load. The result in the changed wiring was that the hoisting limit switch was inoperative as protection against overhoisting. This meant that the crane operator had to watch the hoisting hook very carefully, and in cases where it did get away from the operator and open the limit switch it was necessary to remove the chain that operated the switch, thereby allowing it to close before the hook could be lowered.

One day the operator neglected to stop the hoisting in time, which resulted in overtravel of the hook and a damaged hoisting cable, together with a jammed and broken limit switch. The wiring was then changed to conform to the blueprint connections. This prevented any overtravel of the hoisting hook, and also made it possible to lower the load from the overhoisted position by moving the controller handle to the down point.

Pump-Motor Starter Damaged

In another application it was desired to start and stop a motor, driving a centrifugal pump, automatically by the use of a float switch. The float switch was intended to operate with two control wires. There being no two-wire control compensator on hand, a three-wire control unit was substituted. The changeover was accomplished by cutting out the manually operated stop and start push-button station. The single-contact float switch was then connected in series with the operating coil in the motor starter.

The operation of the control was satisfactory for several months. One day an overload came on the pump which caused the automatic reset overload relays in the compensator to trip it off the line. As the starting and stopping circuit remained closed as long as the float switch was in the up position, this caused the starter to stop and start the motor in rapid succession, as fast as the overload relay could reset. The starter was in service on an alternating-current system and the rapid making and breaking of the motor current probably built up a transient voltage which caused the contacts to flash over, with considerable damage to the control .

An automatic starting compensator using a two-wire control circuit should be equipped with hand-reset overload relays to prevent continuous starting and stopping of the starter in case the overload relay trips the starter This fact was overlooked when the three-wire control compensator was changed over for two-wire control operation.

There are many chances for unexpected trouble to develop in the changing of control equipment wiring that the man with a limited experience with the equipment is likely to overlook. For this reason any contemplated changes should be carefully thought out, or better yet, taken up with the manufacturer of the equipment.

Any one who has ever attempted to locate trouble in a complicated wiring system, where short cuts and changes have been made, knows what a job it is to make headway with it. For this reason any changes made in the control wiring should be clearly indicated on the wiring diagram furnished with the apparatus. This will often prevent serious accidents to the equipment and workmen as well. It is also of great aid when tracing out troubles in the system.

PRACTICAL AIDS TO OPERATION

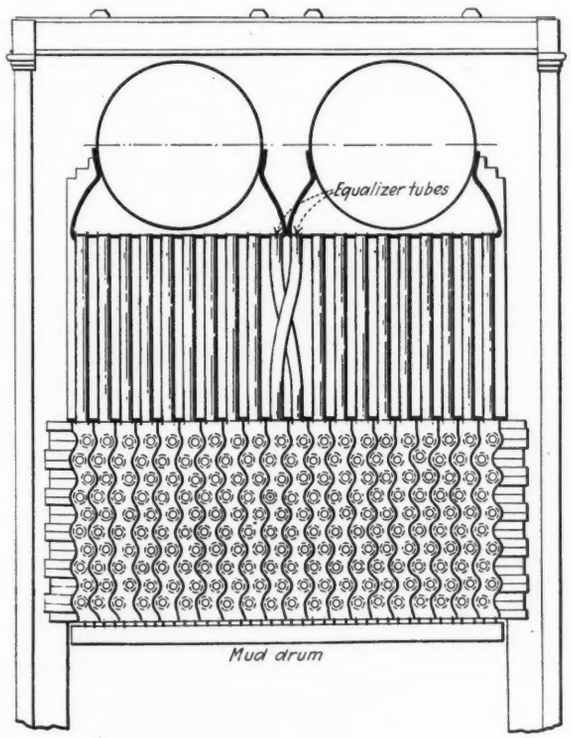
Improving Water Circulation in Water-Tube Boilers

IT IS WELL KNOWN that the internal surfaces of a boiler can be kept free of scale and corrosion if a careful analysis and investigation is made of the feed water and it is then treated accordingly; but satisfactory results can only be obtained when the feed water, when introduced, mixes thoroughly with the water already in the boiler.

Many engineers who are familiar with and who have applied modern methods of feed-water treatment, still fail to obtain desired results, because the design of the boiler which they are operating does not permit speedy and intimate mixing of the water already in the boiler with the freshly introduced feed.

Longitudinal circulation alone is not sufficient to produce this result in all cases, as it has been found with boilers of certain design that where only fore and aft circulation exists the water on one side of the boiler has quite a pronounced variation in chemical analysis as compared with the drum and tube sections on the other side.

Close investigation of the water conditions in certain types of water-tube boilers having two or more top drums running longitudinally will show that although the front-to-rear circulation is quite good, satisfactory mixing is not obtained. This condition can usually be readily recognized by closely watching the water level in all the top drums of a unit. If there is a difference of level in any two drums at the one time it is safe to assume that mixing is unsatisfactory.



Crossing the two center downcomer tubes at the rear gives more uniform concentration

Samples of water taken at the same time from different parts of a boiler, which in operation gives this indication in the gage glasses, will usually reveal, on analysis, such variations that it is practically impossible to determine correct feed-water treatment.

In the horizontal two-drum header type unit the only cross connection below normal water level is the mud drum below the headers at the rear of the boiler. Now, provided that each half is evaporating exactly the same amount of water and exactly the same quantity of feed is entering each drum, there is no inducement for the water in one half to mix with that in the other half. However, in practical operation, this condition rarely exists, as it is found that either one side steams more than the other or else the opening of the feed checks vary slightly. For the purpose of demonstration it is assumed that the left-hand side of the boiler is evaporating more water than the right, with an equal flow of feed to each, or that, with equal evaporation in each half, the right-hand side feed check valve is open wider than the left. There will then be a cross flow in one direction only, from right to left, by way of the mud drum, in which case practically all the scale-forming matter, both in solution and suspension, will be flushed from the right half to the left half, where, owing to high concentration, some of it will deposit as scale, and the right-hand side will contain water of about the same analysis as the feed, that is, of low alkalinity.

If, now, a sample were taken from the left side and analyzed, the water treatment indicated would be: Less soda, owing to high alkalinity, and blow down to reduce concentration of scale-forming matter. If the sample is taken from the right-hand side, the treatment would be: More soda, due to low alkalinity, and there would be no need to blow down, as there is little scale-forming matter present. If a sample is taken from both sides, the results of an analysis will bewilder the operator.

As the water in the left-hand side will be of higher mean temperature, therefore of less density, the water level will be higher and show higher in the gage glass than on the right-hand side, the whole boiler being in effect a U-tube with hot water in one leg and cooler water in the other.

On a bank of boilers where it was observed that this condition existed, cross circulation was established by crossing the two center downcomer tubes at the back end of each. The two original tubes were removed and two new ones fitted, one of which connected the right-hand drum to the header which was originally connected to the left-hand drum, and vice versa.

After this alteration had been made chemical tests were carried out on samples of water taken from different parts of the boiler, and were found to be identical, thus proving that circulation and mixing was as it should be.

Mixing is now so effective that with only one feed valve open an even water level can be maintained in both drums under all load conditions, and the analysis of a sample of water taken from any point of the unit is truly representative of the whole contents, which permits of definitely determining correct treatment of the feed.

C. BOEHM.

Victoria, Australia.

CURRENT COMMENT

Use of Asphaltum Paint on Pipe Joints

I WAS MUCH INTERESTED in the letters in recent numbers of *Power* on the best method of securing tight-threaded pipe joints and wish to state results of my experience in the past three years, not only on threaded joints, but also ground joints.

About two years ago we were installing some new piping and ran out of red lead. Not wishing to wait for more to be delivered, I started looking over the stock to see what I could find that would do instead. I found a can of black asphaltum paint and told the workmen to use it. The results were surprising; the joints stood up from six to nine months instead of the three or four months as when red lead was used. I now have pipe joints that have been in service nearly a year without any sign of a leak.

My method of applying the paint on these joints is: After the pipe is threaded wash the threads with gasoline to remove all the oil and wipe perfectly dry, or better still, if possible let them dry in the air. I have had the same good results with ground unions. First wash with gasoline, wipe perfectly dry, paint both sides and put them together without turning the joint if possible. I now use the paint on all joints where it is possible. The joints will come apart as easily as when red lead is used.

I. F. MOORE.
Buffalo, N. Y.

Preventing Single-Phase Operation On Three-Phase Circuits

POOR TERMINAL CONNECTION at the fuses, causing heating that raises their temperatures above the melting point, is a common cause of fuse failures. On the three-phase line referred to by R.C.M. in April 15 number there may be quite a load of single-phase furnaces or heating elements. If these are controlled by recorders the whole load may be thrown on at the same time. By checking the load it may be possible to divide it on the three phases to obtain a better distribution. If no trouble can be found, put a recording ammeter on the line, changing from one phase to another to see if heavy peak loads occur. Watching the curve, co-ordinate what happens on the line with the change in the current readings. One of the larger motors on the system may have a defective contact on its starter which does not always make contact when starting and throws a heavy single-phase load on the circuit.

Several years ago, at an automobile plant, we had a 40-hp. motor driving the lineshaft. This motor began to give trouble by failing to start at infrequent intervals. After a considerable period of searching for the cause by checking connections at switches and fuses, inspecting the starter's contacts, and checking up on the load, it was discovered that a test lamp would light brightly across one phase and was dim when connected to either of the other two phases. An examination of the non-renewable fuses at the main switchboard revealed that the fuse terminal inside of one cartridge was loose, where it has been riveted to end cover. Replacing this fuse corrected the trouble.

J. W. HEPNER, *Chief Electrician,*
Cleveland, Ohio. Standard Tool Company.

IF A THREE-PHASE MOTOR has running fuses of such a size as to carry 10 per cent overload only, they will blow and stop the motor provided the load is at least 65 per cent of its rated capacity. Should the load be less than this and never greater, either of two things may be done: A smaller motor may be installed for the drive so that the load will be nearer the motor's capacity or the running fuses for a rating of 15 per cent more than the line current corresponding to the load carried by the motor may be used. Under these conditions the fuses will not blow during a momentary load of 20 per cent above the normal and will blow on single-phase operation. It is assumed that the line voltage is within 10 per cent above or below the rated voltage of the motor.

It is advisable to obtain records of the load conditions of the motors and check their temperatures during normal conditions with the hand. In this way one will soon become familiar with the operating condition of each motor and at any time may judge its condition fairly closely.

Due to the motor when running single-phase becoming a phase converter, a voltmeter connected across a blown fuse may not give any indication of voltage, especially if the scale reading is suitable for line-voltage measurements and if the motor is lightly loaded. A voltmeter with a maximum scale reading of about 10 or 20 per cent of the line voltage may be used to check the fuses by first measuring the voltage across the terminals of each fuse with another voltmeter suitable for line voltage: If this meter fails to give any reading, repeat the test with the low-reading voltmeter. If the smaller voltmeter does not give a deflection the three fuses are probably intact.

The surest and safest way to determine if a three-phase motor is running single phase is to measure the three line currents with a split-core current transformer and ammeter. The defective line will either show zero current or a much lower current than the other two. By checking the mains and feeders one may easily determine where the fault lies.

E. MOLINET,
Delicias, Oriente, Cuba. *Electrical Engineer.*

Seal Pipe on Feed-Water Heater Solves Overflow Difficulty

REFERRING to the letter of D. J. Allison, on page 136, Jan. 26 number, entitled "Seal Pipe on Feed-Water Heater Solves Overflow Difficulty," he could have eliminated the 22-ft. drop loop for a short loop by using a weighted check valve below the snifter pipe connection. As sediment is likely to collect in such loops, whether they are short or long, it is advisable to use plugged ties at the bottom of the loop so that the loop can be cleaned out at intervals.

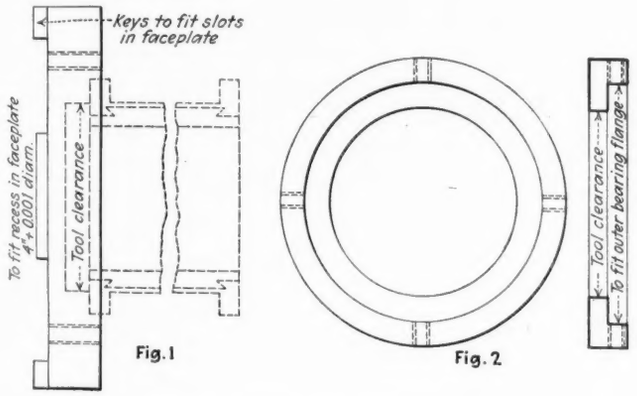
J. E. NOBLE.
Toronto, Ont.

Repair Equipment for the Diesel Power Plant

In an article in the Jan. 12 number entitled "Repair Equipment for the Diesel Power Plant" Louis R. Ford directs attention to the reduction in the cost of maintenance that can be secured in a diesel power plant by the installation of a few suitable machine tools, particularly where the plant is situated in a district where the facilities for repair are limited. He emphasizes the adaptability of the lathe and also points out that the diameter of the engine pistons should be the limiting factor in the size of lathe chosen.

While agreeing with the foregoing, the question of the selection of a suitable lathe cannot be so briefly stated. That the diameter of the engine pistons can be used to decide the swing of lathe centers is accepted, but this entirely ignores the advantages to be derived from a hollow-spindle, gap-bed lathe, provided with a suitable chuck and faceplate; the faceplate to be of a size that will allow offset work to be machined, using the customary balance weights.

Where bearings require new babbitt and the base of the bearing is of the flat rectangular shape, an angle-plate bolted to the faceplate is a more accurate method of setting and reboring than gripping the work in the chuck

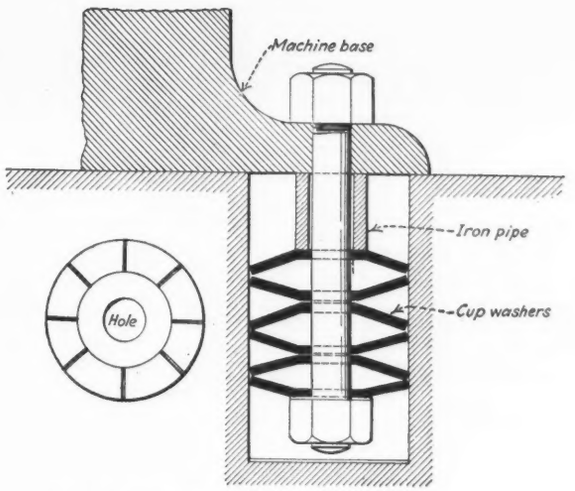


Bearing adapter and clamping ring

jaws. Where the main bearing bushing requires rebabbiting and boring and these bearings are circular in form the use of an adapter, Fig. 1, fixed to the lathe faceplate, and the bearing clamped in place, and the halves lightly secured by clamps or a ring, Fig. 2, will give accurate results combined with rigidity. General practice among diesel engine manufacturers in machining bearings is to use methods which insure the halves being equal. With the use of the suggested adapter correct alignment is secured and a more rigid boring bar can be used.

In dealing with the wear of piston ring seats Mr. Ford suggests that where the wear of ring seats is excessive, thus making the land between the rings too narrow, after remachining, the welding in of new metal can be adopted. This is a suggestion that requires careful consideration. This plan of cutting the ring seat wide and rebuilding with welded metal has been used recently in the construction of some marine diesel oil engines, but it has also necessitated the use of the expensive super-alloy or tungsten carbide steel tools to cut the welded metal. From the foregoing will be apparent the necessity for caution before adopting the welding process, as the success of this procedure depends upon suitable tools being available for machining.

Glasgow, Scotland. Donald Raeburn.



When bolt is drawn up the washers are forced into the concrete

Gripping Foundation Bolts for Heavy Machinery

With reference to the sketch of J. E. Noble in the Feb. 9 number relating to washers used to wedge in foundation bolt holes for heavy machinery, we have been using cup washers only for this purpose. The accompanying sketch shows what, in our opinion, is an improvement over the method given by Mr. Noble. This design eliminates the sagging of the washers under strain, and gives a uniform grip on all washers.

Philadelphia, Pa. A. J. Kuzmann.

Regulator Valve Diaphragms

In the March 22 number, page 446, H. J. Pribensen has a description of a metal diaphragm which he constructed for use instead of rubber in connection with oil pressure.

There are two ways of overcoming the difficulties which Mr. Pribensen experienced. Material can be obtained known as "balloon silk," a fine fabric coated on both sides with a substance impervious to cold oil. Note that hot oil will gradually leak through. If a piece of balloon silk is interposed between the oil and the rubber diaphragm in such a way that heat cannot reach it there will be no appreciable deterioration of the rubber for a long time. This method can be employed in connection with any spring- or weight-loaded valve.

Where extreme sensitivity is desired or where hot oil will come in direct contact with the diaphragm very thin sheets of stainless steel can be used as diaphragm material. These cannot be used in the ordinary valve because the limit of sensitive flexure of the steel is only a few hundredths of an inch at most. Some means must, therefore, be designed to magnify this small motion of the steel diaphragm to operate electric contacts, pilot valves, etc. These, in turn, control the movements of a regulator which is connected mechanically to the valve. Stainless-steel diaphragms have been used in this manner for controlling pressures ranging from a few pounds up to 1,500 with very satisfactory results.

Philadelphia, Pa. James S. Merritt, Jr.

READERS' PROBLEMS

SPOTTING LEAKY TRAPS—*How can we tell whether traps on high-pressure steam line condensate drips are leaking steam, and, if so, how much?* G.E.A.

If the condensate is still above 212 deg. when it reaches the trap part of it will flash into steam at the trap discharge and give the appearance of steam waste. To distinguish this from actual blowing of steam through the trap a calorimeter may be improvised from a barrel of water set on platform scales.

Weigh the empty barrel. Fill the barrel partly full of cold water and weigh it again. Also take the temperature of the water. Use a short length of hose or pipe to deliver the discharge of the trap below the surface of the water for a period long enough to add from 10 to 50 lb. to the weight, but not long enough for the water to get very hot or for much heat to be lost by radiation or evaporation. Measure the final temperature and weight.

Multiply the original weight of water (only) by the original temperature minus 32. Multiply the final weight by the final temperature minus 32. The difference is the heat added to the barrel. Divide this by the weight of trap discharge added. This gives the heat, above 32 deg. F., in a pound of trap discharge. Look up in the steam tables the heat in one pound of water at the steam pipe pressure and saturation temperature. If the heat in one pound of trap discharge is greater than this it is proof of steam waste.

To estimate the amount of this waste assume the round figure of 1,000 B.t.u. for the latent heat of steam. See what percentage of 1,000 the *excess* heat per pound of discharge is. The weight of steam wasted will be the same percentage of the total discharge. Thus an excess heat of 300 B.t.u. per pound of discharge will mean that about thirty per cent of the discharge is steam.

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EFFECT OF STEAM PRESSURE ON COAL CONSUMPTION—*How much more coal will be required to generate 100 lb. of steam pressure than is required for 50 lb., the feed temperature and amount of steam used being the same in both cases. I am using a 2,000-sq.ft. hand-fired boiler.* J.T.

There will be a very slight increase in coal consumption, probably of the order of 2 or 3 per cent. The actual coal "waste" due to the higher pressure will be less than that.

Questions of this sort are raised so frequently that comments are in order. The inquirer here was careful to specify that the same amount of steam was to be produced in both cases. Actually, if the steam is to be used for heating purposes, the amount of high-pressure steam required should be slightly less than that of the low-pressure steam it replaces, although the difference might be too small to measure. This is true because the heat put into the *total steam production* for a given heating load will be constant regardless of the heat put into each pound. Higher pressure will require slightly more heat per pound and slightly fewer pounds, so that the two effects exactly cancel.

Assuming feed water at 212 deg.; the heat put into a pound of 50-lb.-pressure steam will be 999 B.t.u. and that put into a pound of 100-lb.-pressure steam will be 1,009 B.t.u. This increase is 1 per cent. For heating purposes 1 per cent less of the high-pressure steam will be required. The two cancel and so there is no loss.

There is, however, a slight actual loss caused by the higher flue temperature with the hotter steam. The higher-pressure steam is 40 deg. hotter than the low. The resulting flue gases will also be approximately 40 deg. hotter. Allowing 15 lb. of flue gas per pound of coal, the corresponding heat loss will be 15x0.24x40 = 144 B.t.u., where 0.24 is the specific heat. With a boiler efficiency of 65 per cent this would represent 144 ÷ 0.65 = 222 B.t.u. With 13,500 B.t.u. coal the true fuel loss resulting from the use of higher pressures would be 222 ÷ 13,500 = 1.6 per cent.

It should be noted that certain local factors may affect the actual results far more than this. For example, a new boiler will frequently be needed for the higher pressure and this will probably show a different efficiency for reasons having no direct connection with the pressure. Again, the set-up may be such that the pressure carried will affect the waste of heat in its applications.

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CAUSE OF MOTOR SHAFT BEING MAGNETIZED—On a 200-hp. direct-current motor the shaft is strongly magnetized. Other motors in the plant are not, and I am trying to find out what caused the shaft of the one motor to be magnetized. Is this magnetism likely to cause any bad effects in the bearings? C.O.J.

When the shaft of a machine is magnetized it is an indication of an unbalanced condition in the magnetic circuit of the field structure or an improper arrangement of the electric circuit coming into and out of the machine. Such a condition does not necessarily mean bearing trouble, but it is well to try and locate the cause and if possible eliminate the stray field.

A reverse field coil on one of the polepieces has been found to cause the machine's shaft to be magnetized. In other cases the trouble has been caused by a short-circuited or a grounded coil in the field circuit. Another cause is the way that the power leads are brought into the machine. For example, if all the plus leads coming into a machine are on one side of a bearing pedestal and all the negative on the other, the conductors will produce the condition of a single-turn coil around the pedestal and a magnetic field will be set up in the machine's bedplate, bearing pedestals and shaft. On large high-current machines this condition has produced sufficient magnetic pull between the shaft and pedestals to cause overheating of the bearings due to excessive loading.

When a magnetic field passes from the bearing pedestal to the shaft the latter becomes a single-conductor armature, cutting the flux and generating a voltage in the shaft sections in the bearings. If the flux is sufficiently dense and the speed high the voltage may be enough to break down the oil film and cause a current to circulate in a closed loop between the ends of the shaft journals and their bearings. If there are oil rings, the current circulation may be from the shaft to one oil ring and to one end of the bearing, then through the bearing to the oil ring at the other end and to the shaft.

An unbalanced magnetic condition in the machine can also be produced by improper distribution of the armature, series and inter pole field-coil leads, which in large, high-speed machines should be arranged so that one neutralizes the effects of the other. Poor

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A Question for Our Readers

IN OUR PLANT we have two 78-in. by 20-ft. and one 84-in. by 20-ft. horizontal return-tubular boiler. These boilers are at present hand-fired, using a good grade of soft coal at $6 per ton. In the near future we contemplate changing to automatic stokers using a cheaper grade of coal, or we might change to oil fuel.

The boilers are set 60-in. from the floor and 40-in. above the grates. The steam demand is 21,000 lb. per hour with a fairly uniform load. It is desired to carry this load with two boilers.

We should like to get all the information we can before making these changes. Perhaps some readers of POWER *have had some experience in this line.* C. H.

Suitable answers from readers if received promptly, will be paid for when published. Typewritten replies should preferably be double spaced.

joints in a divided field frame will produce magnetic unbalance that may cause the machine's shaft to be magnetized and produce shaft currents. Certain combinations of armature windings may cause magnetic unbalance, as will poor joints in the end rings of squirrel-cage rotors with sectionalized end rings. For a comprehensive study of stray magnetic fields and shaft currents in electric machines, see Nov. 18, 1930, number of *Power*, Page 798.

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A Simple and Practical System For Filing Tracings

WHAT SYSTEM has been found most satisfactory in filing tracings made up relative to the plant alterations and new construction work handled by most plant engineering departments? The maintenance work referred to would consist of all carpenter, painting, sheet metal, plumbing, millwright, machine and electrical work. N.M.J.

GENERALLY each question submitted to *Power* readers brings a flood of replies, many more than can be published. Not so with the question of N.M.J. regarding the filing of tracings. Evidently most *Power* readers feel that boilers, engines, heating and ventilation are more in their line. Nevertheless, tracings and blueprints are lying around many a power office crying for a file. Their owners will find the following suggestions of Geo. P. Pearce easy to follow and thoroughly practicable where a moderate number of tracings is handled.—EDITOR.

THE MOST practical system I have ever seen for keeping track of tracings that come under the plant engineer's jurisdiction is one that at the same time is exceedingly simple and requires scarcely any attention.

This system was started by setting up a drawing record book. In this book each ruled line was numbered consecutively. As drawings were finished they were entered on the next blank line and given the same serial number. The entry consisted of the title, the draftsman's initials, the date and the drawer number where it was to be kept. This drawing record book thus kept track of the numbers, supplied the number for the next drawing and showed what drawer the tracing was in.

It was also decided, when this system was started, that all drawings would be confined to one size only—24 in. x 36 in. It might be mentioned here that this size has proved very satisfactory. Occasionally a small detail may seem to be using a lot of tracing paper, but these are rare instances and the complication of having several sizes of paper would have cost far more than the small extra amount of tracing paper used.

A unit-type steel cabinet was next purchased with drawers about 26 in. x 38 in. so the tracings could easily be slipped in.

These drawers were then numbered and classified. The classification was carefully selected so that each drawer covered a definite field of that particular plant. As these important items are rarely the same for two different plants these have to be determined to suit the conditions where the system is to be used.

To illustrate the idea a sample of classification is given below:

(1) Boiler room.
(2) Buildings
(3) Compressed-air system.
(4) Conveying systems.
(5) Cranes.
(6) Furnaces.
(7) Heating and ventilating.
(8) Jigs and tools.
(9) Illuminating.
(10) Power distribution.
(11) Power plant.
(12) Boiler room.
(13) Shafting and drives
(14) Special machines
(15) Steam distribution.
(16) Water system.

The classification was carefully gone over to be sure that any drawing would have to come under one of the headings. This completed the job, with a definite place for everything.

When a drawing is made, with this system in operation, it is given the next serial number and the drawer of the classification under which it falls. It is then filed in that particular drawer without any further ado and the job is done. Now if at some time in the future the equipment covered by the drawing requires repairs the drawing is quickly found by looking through the drawer covering that classification.

If someone asks for a blueprint and simply gives the drawing number, then the record book is referred to; that immediately shows which drawer to look in. As the drawings are in the drawer in numerical order (but of course with many gaps) it is quickly found.

There is only one place for each drawing to go, for the drawer number is plainly marked on each tracing and there are no cards, cross indexes or other records to bother with and get tangled up in. No tracings are permitted to leave the files except just long enough to make the blueprints and these are never returned or stored except by the shop foremen. This avoids difficulty due to division of responsibility for keeping the file in order.

When information is wanted about any piping system, special machine, building or what not, it can be found by going directly to the proper drawer and getting it. GEORGE P. PEARCE.

Moline, Ill.

Boosting 10 Lb. Steam to 50 Lb.

THE FOLLOWING comments apply to the answers (published April 26) to the questions asked by J. F. M. in the March 22 issue of POWER. It will be recalled that J. F. M. asked whether it would be practical to boost the pressure of a portion of the available exhaust steam from 10 lb. to 50 lb. pressure for a process requiring that pressure. He hoped to justify this by the resulting reduction in the amount of 150 lb. steam reduced to 50 lb. for this process.—EDITOR.

THE TOTAL amount of 2,500 lb. per hr. of 50-lb.-pressure steam does allow much room for justifying savings by any changes.

The thermocompressor suggested by K. K. Fischer seems to be the most feasible of the published suggestions. Even this suggestion shows a yearly saving of only $300 on an investment of $450, and it is not known whether or not it would be necessary to make extensive pipe changes.

I doubt whether the small pump suggested by E. E. Clock could be justified. The savings shown by E. L. Ningard are based on a steam cost of 80 cents per 1,000 lb., which is about 30 cents too high for an efficient industrial power plant of average size.

I think more of L. A. Corwin's suggestion than of any of the others published. He points out that it may be possible to use 10-lb. steam instead of the 50-lb. as at present. My experience has been that many operators specify pressures that are unnecessarily high. In other words, it may be possible to increase the heating surfaces or use direct steam at 10 lb. and thus eliminate the use of 50 lb. altogether. If it is absolutely necessary to use 50-lb. steam, and the requirements are only 2,500 lb. per hour, there does not seem to be any better way to furnish it than through a reducing valve as at present.

There is one suggestion which may be considered if the 50-lb. steam is used in coils: That is to have the steam traps discharge into the 10 lb. system during periods of deficiency. Of course, it would be necessary to take care of the water from these traps.

Finally, I should suggest that J. F. M. study very carefully the savings on any suggestion offered, since the possibilities as listed do not provide much room for justifying any extensive expenditure.

Parlin, N. J. G.E.L.

Photo-Electric Recorder Has High Sensitivity*

A photo-electric recorder that combines the advantages of direct-acting recorders with those of a sensitive indicating instrument has a separately excited recording element to make the record and a sensitive indicating instrument to control the movement of the recording element so that the record obtained represents the reading of the basic instrument

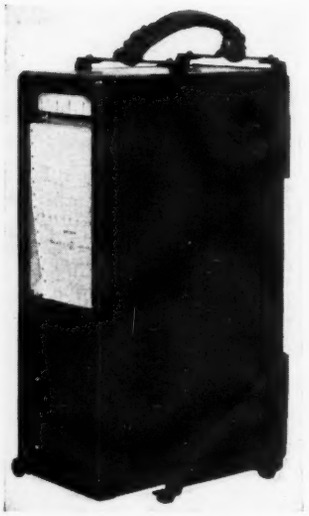


Fig. 1 — Portable type photo-electric recorder

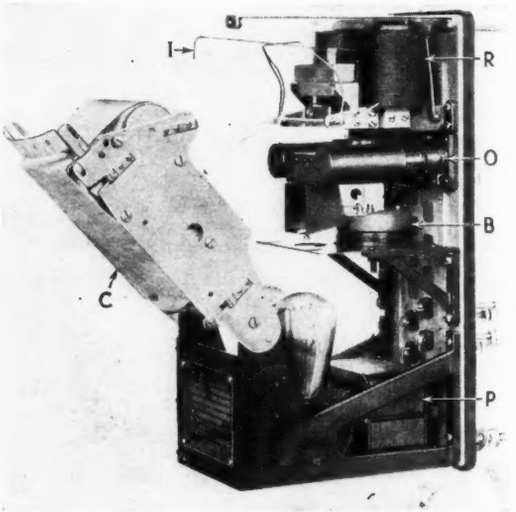


Fig. 2—Interior of a photo-electric recorder
B is the basic instrument; *C*, chart carriage; *I*, inking pen; *O*, optical system; *P*, power unit; and *R*, recording element.

By C. W. LaPIERRE

DIRECT-ACTING recorders of the usual types are the heavier and higher-torque counterparts of corresponding indicating instruments. Although such recorders have some highly desirable characteristics, such as a continuous record and a rapid response, they cannot be made to approach indicating instruments in sensitivity. A photo-electric recorder has been developed that combines all the advantages of direct-acting recorders with those of the most sensitive indicating instruments. This is accomplished by providing a separately excited recording element to do the actual work of making the record. A sensitive indicating instrument controls the position of the recording element, so that the record obtained represents the readings of this basic instrument. The loss in the sensitive basic instrument is the only power required from the measured circuit.

The link between basic and recording elements consists of a combined optical system and photo-electric circuit. The basic element itself rotates a galvanometer mirror through an angle corresponding to its reading, and can be even more sensitive than the usual indicating instruments with pointers. On the other hand, the recording element may readily possess as much torque and be as heavy and sturdy as desired without affecting the basic element or measured circuit in any way.

As a result, the photo-electric recorder possesses all of the desirable characteristics of the direct-acting type, and at the same time is capable of a sensitivity and a rapidity of response equal to the highest sensitivity indicating instruments. In general, anything which can be indicated can now be continuously recorded by means of the photo-electric recorder.

An external view of one form of the photo-electric recorder is shown in Fig. 1. The instrument is completely self-contained, requiring only an auxiliary power source of 115 volts, 60 cycles, and is available for either portable or switchboard use. The internal parts of the recorder may be grouped into five units: The basic indicating instrument or galvanometer, optical system, recording element, chart carriage and power unit, their relative locations being shown in Fig. 2.

The basic instrument is the only measuring device within the recorder. For use in the recorder their pointers are removed and replaced by a small galvanometer mirror usually mounted on the axis of rotation, just above the basic instrument proper. The optical system includes mirrors on the basic and recording elements and a fixed reflector. In general, the optical system comprises a group of reflectors so arranged that whenever an angular displacement between the recording and basic elements occurs there is a shift in the light distribution between the photo-electric tubes, of the proper direction to react on the recording element and reduce the displacement to zero. Thus the optical system always acts to maintain the recording and basic elements in the same angular position.

The photo-electric circuit which supplies the actual energy used by the recording element is shown in Fig. 3. The output of a secondary winding on the auxiliary supply transformer is rectified and applied to the field coils of the recording element. A capacitor in parallel with the field coils provides additional filtering, so that the pulsations in the resulting direct voltage are considerably reduced. The voltage so obtained supplies the pliotron plate and the photo-electric tube circuits. Other windings on the auxiliary supply transformer provide voltages for the lamp, rectifier and pliotron filaments.

Of greatest importance is that part of the circuit beyond the field coils of the recording element. A portion of the direct voltage across the field coils is applied to the three-element pliotron tube. The plate current of this tube passes through the recording element armature connected in the filament side of the circuit to permit grounding one armature lead. Another portion of the voltage across the field coils is applied to the two photo-electric tubes in series. Their common junction is connected to the grid of the pliotron. This circuit is capable of very high sensitivity to changes in the distribution of illumination between the two tubes.

The slightest unbalance of light in a given direction between the tubes will throw the grid voltage to one extreme.

*Abstract of a paper "The Photo-Electric Recorder," presented at the winter convention of the American Institute of Electrical Engineers, held in New York City. The author is in the general engineering laboratory, General Electric Company, Schenectady, N. Y.

A slight unbalance in the opposite direction will throw the grid voltage to the opposite extreme. These extreme grid voltage swings occur far too fast under normal conditions to make the circuit useful for recording. The high sensitivity may be retained with all its advantages, however, and still have the circuit as slow in operation as may be desired. This is accomplished by inserting between the grid and filament a capacitor and resistor in series. It is now necessary to alter the charge upon the capacitor before the grid voltage can change, and the time lag of this procedure may be adjusted to any degree by changing the value of the capacitance.

The recording element contained in the instrument in Fig. 2 differs from the D'Arsonval type in having an electromagnet instead of a permanent-magnet field. The armature consists of a coil moving in the gap formed by the pole-pieces and core. The armature current is obtained from the pliotron tube and is under control of the photo-electric tubes. The field winding derives its current from the output of a rectifier on the secondary side of an auxiliary supply transformer. This transformer is contained in the power unit and also

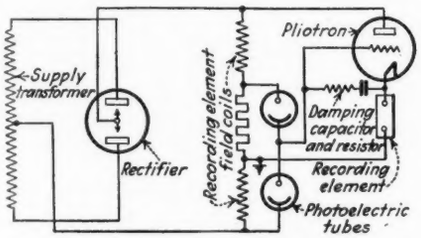


Fig. 3—Diagram of recorders photo-electric circuits

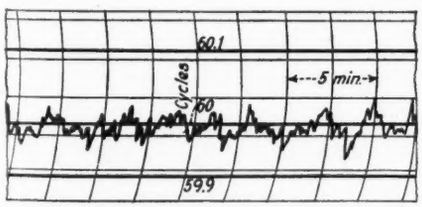


Fig. 4—High-sensitivity frequency record

supplies all filament and other necessary voltages. The electromagnet field serves an additional function as the voltage divider and filter inductance for the direct current supplied to the pliotron and photo-electric tubes.

The inking system, comprising a syphon pen and a fixed ink reservoir and the chart carriage are of conventional design.

For direct-current measurements the basic element is usually the same as is found in miniature indicating elements, except that a galvanometer mirror is substituted for the pointer. Such miniature elements are available to provide recorders of as low as 75 microamperes full scale and having a resistance of 350 ohms. Higher currents and other resistance values are also available. A low watt-consumption element may be used having a full-scale current requirement of 300 microamperes and a resistance of only 10 ohms. A recorder containing this instrument would require less than one microwatt from the measured circuit at full-scale deflection. With larger elements, of slightly more expensive construction, current sensitivities of 20 microamperes full scale can be provided with a watt consumption of approximately 0.3 microwatts.

Other elements are, of course, available for recording other quantities. For instance, high-sensitivity frequency recorders can be constructed with a scale range of 1 cycle at 60 cycles; high-sensitivity voltage recording with a scale of as low as 4 volts on a 115-volt circuit; pressure recorders with full-scale pressures down to approximately 1 or 2 in. of water; or, in general, anything for which there is some sort of an indicating instrument, can be continuously recorded with a photo-electric recorder.

The rapidity with which the recorder responds to fluctuations in the measured quantity is of the same order as the response of the basic element. In most cases the instrument responds to a change from zero to full scale within one second, and the usual fluctuations require a much shorter time.

The optical system and photo-electric circuit described above is self-compensating for all normal changes in these variables. Variation in the auxiliary supply voltage is transmitted to all parts of the photo-electric circuit; however, within wide limits, such variations do not affect the accuracy of the recorder. Changes in pliotron characteristics such as occur due to variation of filament emission, etc., are automatically compensated for by the circuit in the same manner as are voltage fluctuations. Changes in lamp illumination such as occur due to normal variations in supply voltage, deterioration of the filament and blackening of the bulb do not ordinarily produce any effect on the recorder during the life of the lamp. In extreme cases of progressive loss of illumination, the operation of the recorder may be slowed up appreciably, without, however, affecting its accuracy.

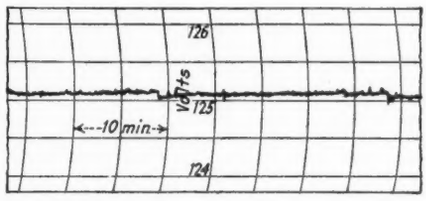


Fig. 5—High-sensitivity voltage record

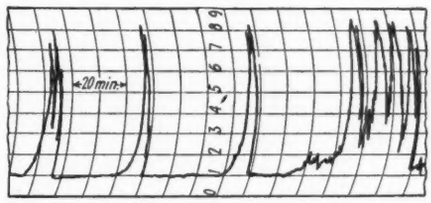


Fig. 6—Record of smoke density

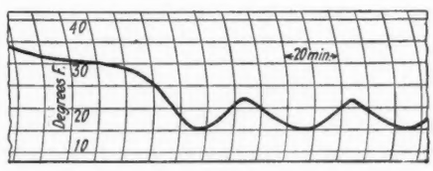


Fig. 7—Refrigeration-evaporation temperature record during test

The reflectors merely direct the illumination along the desired paths, and variations in their reflecting power, such as those due to accumulations of dust, have the same effect as variations in lamp intensity. Variations in photo-electric tube sensitivity may be added as the final possible source of error of any magnitude. Here again, through proper design of the optical system, the effects of changes in photo-electric tube sensitivity have been reduced to a secondary and negligible order of magnitude.

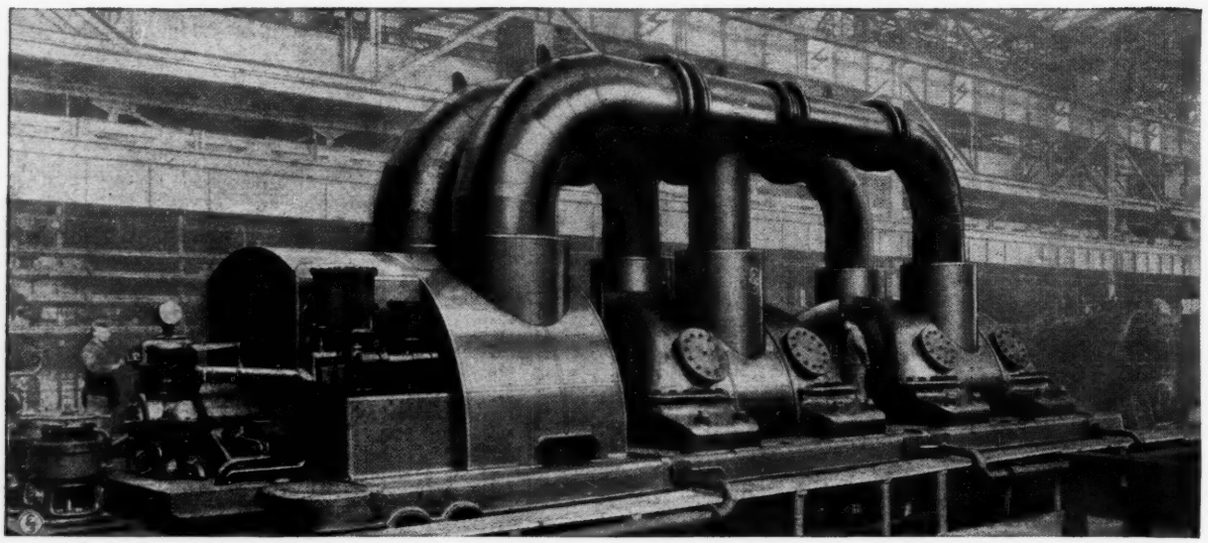
Tests show that after photo-electric tubes have been in service a while they tend to become quite stable and will maintain their sensitivity fairly constant over long periods. The other possible sources of error include pliotron-grid currents, photo-tube dark currents, and leakage currents in the grid circuit. All of these tend to affect the results in the same way as a change in photo-tube sensitivity. There is no difficulty, however, in reducing the magnitude of all stray currents to from one-tenth to one-twentieth of the actual control current. When of this order their effect is entirely negligible.

Several of the photo-electric recorders both in experimental and commercial forms have been under observation in actual operating conditions for some time. Results are in many cases such as could not be obtained by any other commercial instrument with which the author is familiar.

Fig. 4 shows a frequency record made on a well-regulated system. A record such as this shows clearly the variation between the control limits of the regulating devices. They are especially useful in studying system frequency disturbances. Fig. 5 is a sensitive voltage record taken on a constant-voltage supply for laboratory use. Fig. 6 shows a record of smoke intensity taken in the stack on a steam boiler furnace. In this case the recorder was used in connection with a photo-electric smoke detector.

Fig. 7 illustrates records taken of variations in the temperature of a refrigerator under test. In connection with an electric gage, continuous records have been taken of paper thickness as it passes from one roll to another. Each small division on the fifty-division chart represented a variation in thickness of 0.00002 in. Other gaging records have been obtained showing the dimensions and distortion of materials under stress. Still other applications include electrolysis survey records, turbine-generator vibration recording, high-sensitivity power recording, small draft pressures, and so on.

LARGEST 3,000-R.P.M. SINGLE-SHAFT STEAM TURBINE



The largest 3,000-r.p.m. single-shaft steam turbine is shown on the test set at the turbine plant in Mluheim, Germany. This unit is to be installed in the power house Schelle in Belgium by the Societe Generale Belge de Production d'Electricite "Interescaut." It will have an output of 60,000 kw. power factor 0.75 and will operate at 500 lb. and 850 deg. F.

Dr. Wickenden Calls 4-Year College Course Inadequate

EVERY ONE concerned with the education of engineers recognizes the utter inadequacy of the four-year college course, said W. E. Wickenden, president, Case School of Applied Science, at the Process Heating Conference held recently in Cleveland. If it were our only resource, we should never be much more than a half-educated profession. The crux of the problem of educating the engineers lies in the fact that there are so many kinds. A few years ago the editor of an engineering periodical undertook to take a census of individual types of engineers, real and so-called. He ran up to about 120, I believe, and was still going strong when death overtook him. Almost no boy in an engineering college can tell in advance what kind of engineer he is going to become, or is willing to take the risks of permanent specialization before he has had a chance to try out the field. The college can only give him a good family connection, and leave him to work out an individuality for himself. Keeping the boys longer in college might help them to get a broader general education but not nearer to their actual life work.

It is clear that if we are to provide a more adequate professional training for the engineer, we must do most of it in the period after he has left school or college. Our engineering societies are recognizing this fact and are taking more and more responsibility for the after-college education of the engineer. In doing so they are returning to their original purpose. Two quite distinct phases of this problem need to be recognized. One is the early period after graduation when the novice is growing up and becoming of age professionally. A movement is now taking shape whereby the national organizations will probably lay down educational guide lines for this period, to culminate in a plan of individual examination and certification of professional standing. The second phase is the period of adult education for the mature engineer.

All the scientific professions are finding it necessary to provide highly specialized clinical training for these mature members. An up-to-date dentist, for example, is likely to attend three brief and intensive clinical schools every year. An officer in the army will spend, on the average, one-seventh of his time in service schools. If any needs this type of education, it is the engineer. The science and art are making strides almost too fast for the unaided individual to keep pace with; new specialties are developing almost over night! Men are making new connections and having to master new fields. A good slogan for the profession would be "Back to school at least once a year."

This is the job that the Cleveland Engineering Society and Case School are tackling together. I do not think either of us could do it properly apart from the other. It is an excellent thing for professors to have a hand in such a job as this and I am sure it is a good thing for educators to give the layman and practitioner something more concrete to do than to stand on the side lines and criticize. It is a good thing for industries to get into this teamwork with the college and the engineering society, for it takes the edge off mere ballyhoo and turns publicity into real education. Finally, it is a grand object lesson for students, a demonstration that the only place for an engineer who has a really finished education is in the cemetery.

Burning Cinders

THE REPORT on "Coal and Ash Handling" just released by the prime movers committee, N.E.L.A., contains an interesting statement by The Edison Electric Illuminating Company as to its practice in burning cinders:

"In the 'L' Street station a cinder burning system has been developed in which the cinders that collect in the bottom of the economizer soot chamber are fed by gravity through pipes to a cinder burner located at about mid-section of one boiler side wall. At the point where the cinders enter the boiler there is a small jet of compressed air which blows them into the furnace, where they are practically all burned in suspension. As this system operated satisfactorily, it was installed on the other boilers in the station. One of these boilers is equipped with a cinder catcher and the cinders from it are also fed by gravity to a burner in the side wall of the boiler.

"In Edgar station the four newer boilers have also been equipped with cinder burners similar to those developed at 'L' Street. In the case of Edgar station, however, the cinders are not taken from the economizers, but from the base of cyclone cinder catchers located on the roof. Cinders are also taken from the bases of the smoke stacks (which are at roof level) and conveyed by gravity to the cinder burners."

Incidently, these cinders have a heat content from 6,000 to 10,000 B.t.u. per pound. Because of the finely divided form, the market locally for such cinders is restricted and it has proved more economical normally to burn them and thus recover the heat than to haul them to a dump, although at present some are being hauled to dumps.

WHAT'S NEW IN PLANT EQUIPMENT

Guide-Rail Lubricator for High-Speed Elevator

To SUPPLY the demands for a device that will properly lubricate the guide rails of high-speed elevators in tall buildings, Albert Johnson, 1150 Broadway, New York City, has placed on the market an automatic lubricator, Fig. 1. This lubricator is designed to apply heavy oil uniformly to the guide rails regardless of the elevator's speed or the height of the building. A nipple threaded through the cover of the oil well *W* supports the oil container *C*. By turning the container, the lower end of the nipple is raised or lowered into the oil well and in this way the oil level in the well is adjusted to obtain the proper feed to the rail for satisfactory lubrication. After this adjustment has been made the container is locked to the oil-well cover by a nut on the nipple. For a given position of the nipple in the well the amount of oil fed to the rail is the same when the container is full or nearly empty. Oil will come down into the well only when the oil level in the well is low enough to allow air to enter the container through the nipple.

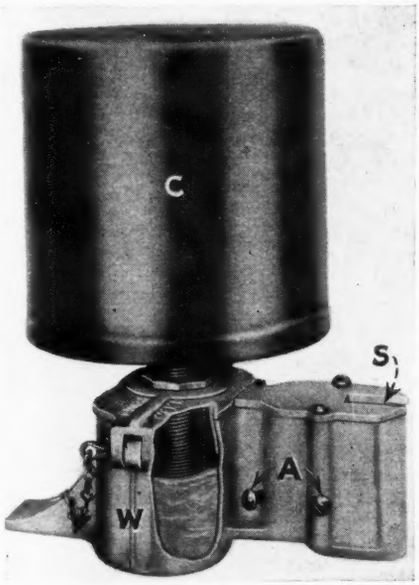


Fig. 1—This lubricator is mounted on the guide shoe

The lubricator is supported on top of the guide shoe so that the guide rail passes through the slot *S* and is surrounded on all three sides by a felt wiper that syphons the oil from the well and equally distributes it on the surfaces of the rail. Any wear on the felt wipers may be compensated for by turning the adjusting screws *A*. An important feature of the device is that it will feed oil only when the car is in motion.

To fill the lubricator, one of the cotter pins holding the oil-well cover in place is removed and the container turned upside down, after which the oil is poured into the container through the nipple. Regular size containers are of $\frac{1}{2}$-gal. capacity. Where space is limited a one-quart container is used.

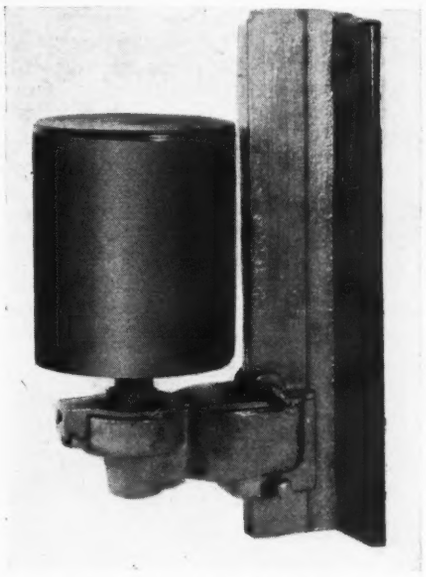


Fig. 2—Stationary-type lubricator mounted on the guide rail

While the lubricator has been designed for high-speed elevators in tall buildings and for heavy-duty garage and factory elevators where the guide-shoe pressure on the rails may be high, it can be used on any type of elevator. The lubricator can be applied to either standard $\frac{5}{8}$- or $1\frac{1}{4}$-in. rails and can be regulated to feed light, medium or heavy oil, leaving the elevator mechanic free to choose the oil best suited for the guide rails under his care. The container holds sufficient oil for from four to eighteen months' service, depending on the type of installation.

To meet the demands for a low-priced lubricator, where the requirements are not as exacting as on high-speed, high-rise cars, the type of lubricator in Fig. 2 has been developed. It is clamped to the top end of the guide rails, but works on the same principle as the type in Fig. 1, and will feed the same grades of oil to the rail.

Foote size 5-HG reduction unit

Reduction Gear Made in Five Types

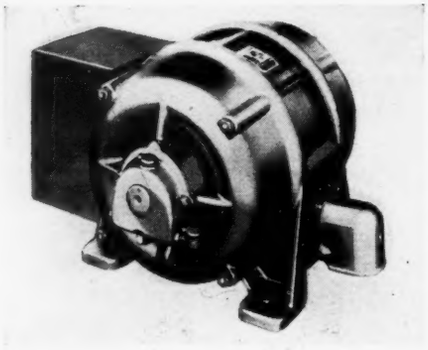
BUILT in five types and a wide range of speed ratios varying from 3.5 to 1 to 3,000 to 1, Size 5-HG gear reduction unit put out by the Foote Gear and Machine Company, 215 North Curtis St., Chicago, Ill., is designed to fill the gap between sizes 4-HG and 6-HG made for some time by that company.

All shafts are heat-treated alloy steel, and radial ball and tapered roller bearings are used. The worm and its shaft are machined from a single nickel steel forging and the gear is hobbed from a special bronze. Lubrication is accomplished by splash system. A special cast-iron bedplate designed for each type of reducer can be furnished for mounting reducer and motor in alignment. The unit is designed to transmit up to 14 hp. continuous duty.

Polyphase Capacitor Motor Operates at High Power Factor

CAPACITORS are usually applied to polyphase induction motors by connecting them across the motor terminals. This produces a high power factor in the power line but does not affect the motor characteristics or the power factor in the motor proper. In the Noel method, announced recently by the Ideal Electric & Manufacturing Company, Mansfield, Ohio, the condenser reactive current is made to flow through the windings of the motor, thereby producing a high power factor within the motor.

This arrangement is said to give polyphase capacitor motor with greatly improved starting and running characteristics. The outstanding feature is that it operates at practically unity (100 per cent) power factor at all loads. One of these motors, it is said, will correct the power factor of two ordinary induc-



Noel polyphase capacitor motor

tion motors of similar size so that the total power factor is near 100 per cent.

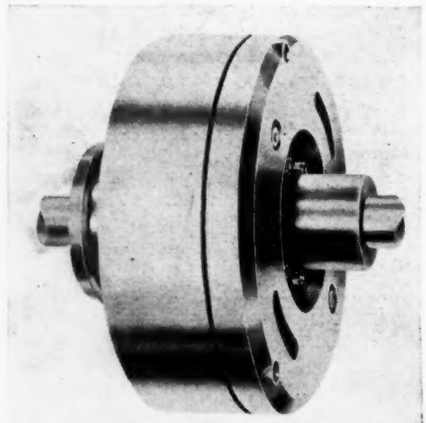
The Noel motor embodies the advantages of the squirrel-cage induction motor and in addition offers the following advantages over the ordinary polyphase induction motor: unity or 80 per cent leading power factor, higher starting torque, lower starting current, increased efficiency and less slip with a resulting higher full load speed.

The capacitors used are the oil-filled, oil-impregnated, hermetically sealed type with individually fused sections. They are assembled in steel cases with conduit connections for mounting on the wall or any convenient location. The Noel polyphase capacitor motor is also made as a slip-ring variable-speed induction motor in all sizes and speeds, and is built in various types to meet all starting torque and inrush classifications, including across-the-line starting in all sizes and speeds up to 200 hp. at 80 per cent leading or unity (100 per cent) power factor.

Magnetic Friction-Type Clutch

TO MEET the demand for a powerful magnetic friction-type clutch of smaller physical dimension, the Dings Magnetic Separator Company, 333 Smith St., Milwaukee, Wis., has introduced the clutch illustrated.

It is of simple construction, with contact faces on both sides of a spring disk which are squeezed between the magnet and armature elements when the coil is energized. Provisions are made for adjustment to compensate for wear of contact faces, and light springs on the armature holding bolts serve to expel the armature when the coil is de-energized, thus assuring ample clearance between the two clutch elements. The clutch is made with and without ball bearings between the hubs of the two clutch members as installation conditions might require to insure proper alignment. Coils are form-wound and vacuum-pressure-impregnated.



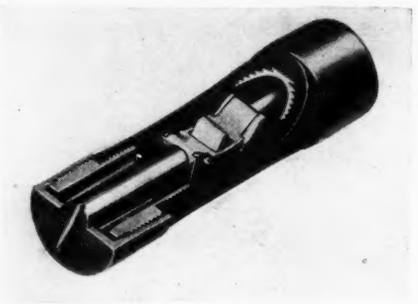
Dings magnetic friction type clutch

It is claimed by the manufacturer that, theoretically, the power transmission of this clutch is double that of single friction contact face, but actually it is of approximately 75 per cent greater torque with same magnet strength.

The company has also developed a single-spring disk clutch following the same general construction as the unit illustrated but having three friction contact faces with the consequent increased torque and power transmission.

New Design of Renewable Fuse

A NEW PRINCIPLE of fuse construction in both the cartridge and knife-blade types has been introduced by the Associated Engineers Company, Chicago, Ill. It is designated AE.



Cartridge Type AE renewable fuse

The design of the new fuse departs from the use of nuts, bolts and washers, as a means of making link and terminal contact. A link is formed to fit on a rigid asbestos "carrier," and positive link and terminal contact are made by terminal pin abutment. A part of the carrier projects between the calibrated portions of the link, making an effective arc barrier. In the knife-blade type, true alignment of the blades is assured by the truss effect created in the mechanical assembly of the fuse.

Oil Seal for Anti-Friction Bearings

THE AETNA OIL SEAL for anti-friction bearings, illustrated, consisting of only four parts, is a self-contained and complete unit which can be slipped in or out of position with nothing to work loose or become lost. It consists of an outer shell of steel housing the seal cushion, pressure plate and steel retainer.

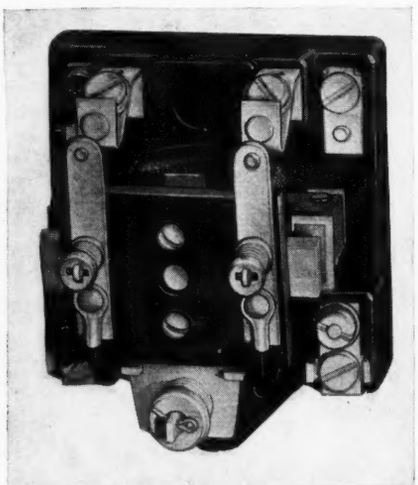
Aetna oil seal

The thermo-pneumatic seal cushion, according to the manufacturer, consists of specially treated cork in which the interstices of air cells are captivated and hermetically sealed. This pneumatic seal cushion automatically expands and contracts laterally with changing temperature of shaft or lubricant. It is non-hygroscopic and impervious, is of great resiliency, has a low friction coefficient and is abrasive-resistant. The deflector-pressure plate —of specially treated fiber—deflects oil from the seal proper, serving to maintain a constant and steady pressure upon the pneumatic cushion and a uniform pressure over the entire periphery of the seal.

The seal is available in sizes from ½ in. inside diameter and up from the Aetna Ball Bearing Manufacturing Company, 4600 Schubert Ave., Chicago, Ill.

Magnetic Contactor for Industrial Control

REALIZING THE NEED for magnetic contactors and relays of small ampere capacity for the accurate control of



Square D class 8511 magnetic contactor

temperature, time, light and energy by electrical means, the Industrial Controller Division of the Square D Company, Milwaukee, Wis., has added two smaller sizes to its line of alternating-current magnetic contactors. These are designated as Class 8511, Types H and K. The range of ratings is from 3 to 15 amp. for non-inductive load or the fractional horsepower sizes of 110-volt single-phase motors.

Important structural features of the larger contactors are embodied in the design: laminated magnet frames, floating armature to insure quiet operation, silver-to-silver contacts, porcelain bases, approved temperature and insulation standards, voltages up to 220 volts for Type H or 440 volts for Type K.

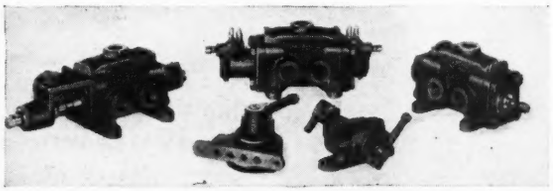
These contactors are built in a variety of combinations, single- and double-pole, single- and double-throw, circuit-opening and circuit-closing service, two- or three-wire control, and three-wire thermostat control.

Four-Way Balanced Valves

AN IMPORTANT FEATURE of the Vickers four-way valves, illustrated, is their hydraulic balance, which prevents them binding due to pressure and assures more sensitive operation. They are designed for use with operating pressures up to 2,000 lb. per square inch.

The valve at the left in the illustration is the latch-controlled type, which makes one complete cycle and then stops. With this valve the operator manually starts the machine in one direction; at end of stroke a stop trips the latch and allows an internal spring to shift the valve to reverse position. When end of return is reached, the machine is stopped by the valve.

A pilot-operated four-way valve with manual and mechanical pilot valves constitutes the center group. It provides remote control without the use of levers, links, etc., and can be placed out of sight or wherever most convenient. It has simple external adjustments for controlling reversing speed. The manually operated four-way valve is shown at the right. These valves are made by Vickers, Inc., 7760 Dubois St., Detroit, Mich.



Three types of Vickers four-way valves

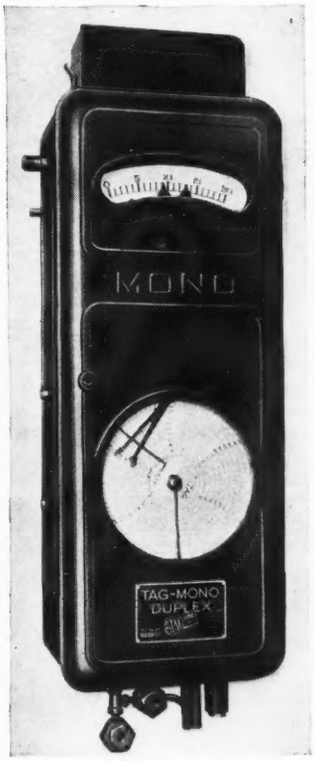
Welding Flux for Stainless Steels

DEVELOPED especially for use in welding the chromium-containing alloys known commercially as stainless steels or rustless irons, Cromaloy flux is said to be sufficiently fireproof to protect the molten metal and hot metal adjacent to the weld from oxidation, and at the same time correctly compounded to dissolve the refractory chromium oxide with ease. It also has high solvent power for chromium oxide and high resistance to heat. It is put out by the Linde Air Products Company, 30 East 42d St., New York City.

Automatic Combustion Indicator-Recorder

THE NEW all-metal automatic flue gas analyzer known as TAG-Mono indicator-recorder, put out by the C. J. Tagliabue Manufacturing Company of Brooklyn, N. Y., not only indicates and records the per cent of CO_2, but is designed to give an accurate record of the per cent of combustibles, such as $CO + H_2$, which may be present in the flue gases.

TAG-Mono indicator-recorder



The instrument works on the orsat principle, analyzing chemically and indicating and recording electrically. A large illuminated dial is used and the pointers can be seen easily at a distance of 30 ft. In addition, the records are made on a 9-in., 24-hour circular chart with open graduations inviting a precise study of the continuous performance.

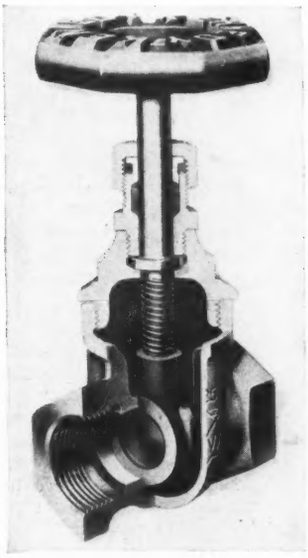
Electric Air Heaters

FIVE RATINGS are included in the line of horizontal electric air heaters for industrial applications announced by the General Electric Company, Schenectady, N. Y. The ratings are 1,000 watts at 115 volts; and 1,000, 2,000, 3,000 and 4,500 watts at 230 volts. The heaters consist of a number of strip units mounted in black-japanned, perforated, pressed-steel cases. Each is equipped with three feet of armored cable and a three-heat snap switch mounted on a standard conduit box. They are designed for wall or floor mounting.

Solid Wedge Stationary Stem Gate Valve

ONE OF THE FEATURES of the standard bronze solid-wedge stationary-stem gate valve illustrated is the extra large bonnet hexagon which is placed close to the hub face joint where it screws into the body. This construction is said to make the valve particularly rigid and also to assist in removal of the bonnet and stem assembly when space is limited. Another feature is the extreme depth to which the stem engages with the disk, providing a large number of contact threads, which precludes the possibility of stripping.

The stuffing box is provided with gland on all sizes and the packing rings are of molded square section and made of a composition which has a high graphite content. The valve, which is manufactured by the Kennedy Valve Manufacturing Company, Elmira, N. Y., is suitable for use on 125 lb. steam pressure and 175 lb. water pressure.



Cross-sectional view of new Kennedy valve

NEWS of the WEEK

Live Technical Program for Bigwin Meeting of A.S.M.E.

PAPERS from three countries—Great Britain, Canada and United States—feature the technical program just announced for the semi-annual meeting of the American Society of Mechanical Engineers, which will be held at Bigwin Inn, Lake of Bays, Ont., Canada, from June 27 to July 1 inclusive. Twelve sessions are scheduled, of which five will be devoted to subjects directly in the power field. In addition the entertainment program includes inspection trips, social events and outdoor recreation amid exceptional scenic beauty.

At the steam power sessions on June 30 and July 1 the following papers will be presented: "British Practice in Steam Turbine Design," by F. W. Gardner; "Steam Turbine Plant Practice in the United States," by Vern E. Alden and W. H. Balcke; and "Economic Balance Between Steam and Hydro Capacity," by K. M. Irwin and Joel D. Justin.

On June 29 and 30 sessions devoted to the subject of hydraulics will be held, at which papers will be read on "Hydraulic Practice in Europe," by R. D. Angus; "Hydro-Electric Development in Canada," by T. H. Hogg; "Hydraulic Jump in Sloping and Horizontal Flumes," by R. W. Ellms; and "Investigation of Flow Conditions in a Centrifugal Pump," by Karl Fischer and D. Thoma.

The oil and gas power session on June 29 will embrace discussions of "British High-Speed Oil Engines," by J. L. Chaloner, and "Surface-Volume Ratio as a Critical Factor in Automotive Diesel Combustion Chambers," by Julius Kuttner.

An interesting feature of the meeting is provided by the applied mechanics sessions, both of which will be devoted to a symposium on the use of models in engineering. Among the papers to be given at these sessions are: "Use of Models Under Centrifugal Force," by Philip B. Bucky; "Model Testing as Applied to Strength of Materials," by R. E. Peterson; "Use of Models in Vibration Research," by J. P. Den Hartog; "Use of Models in Studies of Stresses in Structures," by George Beggs; and "Use of Models in Determining the Strength of Thin-Wall Structures," by H. E. Saunders and D. F. Mindenburg.

Metal Creep Studied at University of Michigan

Creep of metal has been measured by the University of Michigan Department of Engineering Research with special instruments giving for the first time continuous readings accurate to one-millionth of an inch. Results of the research are expected to be of fundamental importance to many industries which must design metal parts for use at high temperatures.

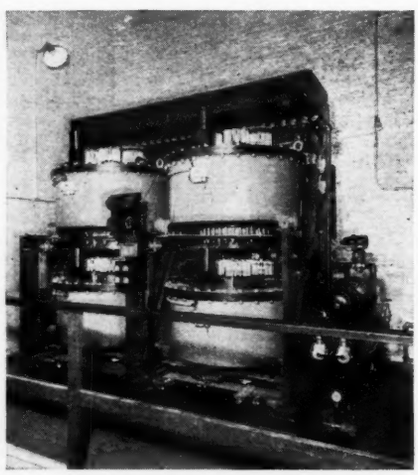
Several methods of measuring creep were developed by Professor Stephen Timoshenko and Dr. F. L. Everett in the University laboratories. The most accurate method devised consists of a new application of twisting force instead of the pulling commonly used and employs a system of mirrors attached to the specimen which, together with telescope and graduated scales, permit detection of extremely minute creep movements. Professor Timoshenko and Dr. Everett, who spent last summer in Europe, are continuing their research in this line, which has been recognized by German scientists working in the same field.

Ontario to Spend $120,000,000 On St. Lawrence Development

Arrangements have been completed for the signing of an agreement between the Dominion Government and Ontario whereby the latter will contribute $120,000,000 to development of 1,000,000 hp. in electric plants on the Ontario side of the international section of the proposed St. Lawrence deep waterway.

The figure of $120,000,000 total cost includes the province's contribution to the joint power and navigation works and the cost chargeable to power alone, such as the expenditure on power houses and transformers. The cost at the source is calculated at $12 per horsepower but when the power is stepped up, it will be $15.

The agreement with Ontario goes far to expedite the conclusion of a treaty between Canada and the United States for the navigation scheme. The power rights of Quebec in that section of the river, wholly within that province, are not interfered with, while, outside of the Beauharnois canal, the remaining works adjacent to Montreal are unlikely to be undertaken for some years.



Operating at the Cedar Manor Station of the Long Island R.R. is the first 3,000-kw. mercury-arc rectifier of Westinghouse's sectionalized design. This unit is completely automatic and is made of four new interchangeable, 750-kw. sections, integrally mounted, fed from a single transformer and easily withdrawn on rollers

Unemployed Engineers in Cleveland to Get Farm Land

ALL unemployed engineers in Cleveland are promised early relief if the plan just announced by the Cleveland Engineering Society matures. Relief is to consist in giving each unemployed engineer the opportunity of raising farm products on land in the Chagrin Valley, on the rim of the metropolitan district.

Through the joint committee on technical employment of the fourteen technical societies in Cleveland, a corporation is being formed which will administer the details of the relief plan. A 1,200-acre tract, owned by Windsor White, formerly of White Motor Company, has been put at the committee's disposal.

There are approximately 4,500 engineers in the Cleveland area, of which some 1,400 now are unemployed. The plan to offer them agricultural relief started with George Trundle, Trundle Engineering Company, who is the chairman of the Ohio Unemployment Committee of American Engineering Council.

It is anticipated that at least 300 engineers will form the first colony. A commissary will immediately be established on the site and food and farm implements will be issued, to be paid for by scrip given each engineer. This commissary will also be charged with selling the farm product, or bartering with merchants for clothes and household necessities. Workers on farm plots may be paid in part cash and part scrip, but the greater per cent will be scrip.

Tents and cots will be given those engineers who prefer to stay on the ground. Transportation will be provided for those who now live in Cleveland, and who prefer to ride to and from the farming center. It is planned to split the acreage up into 10-acre tracts, each man will be given one acre to work, and each 10 acres will have a superintendent. Then the farm will have a superintendent. The whole corporation will be headed by a man of responsibility and business ability, who will manage the farm, commissary, etc., for the engineering society.

California Voters Defeat Oil and Gas Conservation Act

Conservation of oil in California still remains an unsolved problem for the Sharkey Act, which provided for such regulation, was defeated at the May 3 election in that state. The bill, which provided for creation of an oil conservation commission of five members elected by state oil company representatives, with a state oil and gas commissioner named by the governor, to prorate the state's production, was passed by the California 1931 legislature and signed by the governor. Immediately following this action a small group of operators opposed to this law circulated a petition against the measure—secured sufficient number of signatures to place the law on the ballot by referendum.

While most all people agree that some

form of regulation is necessary and proper, the voters, by overwhelmingly defeating the act on the ballot, declared that the so-called Sharkey bill was not the proper law for regulation of the oil industry in California. Governor Rolph has urged that those who opposed the Sharkey Act formulate a measure which will best safeguard the interests of the State of California in the production of natural gas and crude oil.

Northwest Welding Congress Attracts Large Attendance

The fourth annual Pacific Northwest Welding Congress was held in Portland, Ore., April 28 to 30, under the sponsorship of the Portland Section of the American Welding Society. The theme of the congress was built around the myriad of uses of welding in industry and 21 firms exhibited examples of various applications. Demonstrations of electric arc and gas welding were carried on continuously and were open to the public at an admission of 25c. Seven hundred delegates from the Pacific Northwest and California registered.

Outstanding educational features at the business sessions were discussions of practical welding methods by H. B. Isings, Woodberry & Company, Portland, and of hard surface methods by Ralph S. Beeler, J. E. Hazeltine & Company, Portland.

The Northwest Congress, now managed by A. Whisnant, had its inception three years ago at the School of Engineering, Oregon State College, Corvallis, when Dean H. S. Rogers of that institution inaugurated the first welding conference.

Plan Diesel Plant for Oregon State Buildings

Bids were opened May 12 for a 740-kw. diesel power plant at Salem, Ore., to serve the state capital building, state office buildings, supreme court, hospital, penitentiary and other state institutions in and around Salem. The specifications, quite general in character, call for two 280-kw. and one 180-kw. diesel generating units operating at 2,400 volts, with distribution lines and transformers and control equipment to serve some twelve of the state institutions .

This action is the outcome of the appointment of a committee by the last legislature to look into the feasibility of serving the state institutions by a state-owned power plant. On this committee were placed engineers associated with the Eugene and McMinnville, Ore., municipal systems and one state senator. Action is being taken pursuant to the report of this committee.

Committee on Water Analysis Formed by A.S.T.M.

A new standing committee of the American Society for Testing Materials has been formed to give consideration to the development of standard methods of water analysis. The society has been interested for some years in the Joint Committee on Boiler Feed Water Studies, but the methods to which the newly formed committee —to be designated Committee D-19 on Water Analysis—will give consideration will involve eventually not only boiler feed water, but all types of industrial waters.

The work of the committee is to begin at once, handling the preliminary stages by correspondence. It is felt that satisfactory progress can be made without an immediate meeting to effect formal organization. The groundwork for the committee's activities has been laid by Max Hecht, chief chemist, Duquesne Light Company, Pittsburgh, who is serving as temporary chairman. A temporary advisory committee has been authorized and will consider questions of personnel and organization matters.

Initially the committee will give consideration to the preparation of standard methods of analysis which are much needed in corrosion tests. These methods will include determination of carbon dioxide, dissolved oxygen and hydrogen ion concentration. Both referee and plant control tests are contemplated.

The committee will welcome any contributions to the work in the form of descriptions of procedures now in use and any data relating to these. This material will receive the attention of the committee if sent to the headquarters of the society, 1315 Spruce Street, Philadelphia.

COMING MEETINGS

American Society of Mechanical Engineers—Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting, Pennsylvania State College, June 8-11. C. W. Rice, 33 West 39th St., New York.

American Institute of Electrical Engineers—Cleveland, Ohio, June 20-24. Headquarters, 33 West 39th St., New York.

American Boiler Manufacturers Association—Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. A. C. Baker, 801 Rockfeller Building, Cleveland.

National District Heating Association—William Penn Hotel, Pittsburgh, Pa., June 14-17. D. L. Gaskill, Greenville, Ohio.

National Electric Light Association—Atlantic City, N. J., June 6-10. A. J. Marshall, 420 Lexington Ave., New York.

Smoke Prevention Association—Royal York Hotel, Toronto, Ont., Canada, June 7-10. Frank A. Chambers, City Hall Square Building, Chicago.

Henry J. Mistele Is Dead; Authority on Power Costs

Henry J. Mistele, chief engineer of the power department of the Falk Corporation, Milwaukee, Wis., died May 1 at his home in that city. He was born in Sullivan, Wis., on Jan. 8, 1865. An authority on power costs, Mr. Mistele specialized in the economic generation and application of steam. He was often called upon to give expert testimony in cases involving combustion and smoke prevention, and was well known for his lectures and articles in the technical press.

Long prominent in the activities of the National Association of Power Engineers, Mr. Mistele was at one time a member of the board of trustees and later served as United States Deputy of the association. He was a member of the American Society of Mechanical Engineers.

R. M. Feustel, President of Midland United Co., Dies

Robert M. Feustel, president of the Midland United Company, Insull holding company, and the Public Service Company of Indiana, died at St. Joseph's Hospital, Fort Wayne, Ind., May 8. He was 47 years old.

Born in Fort Wayne, he was graduated from Purdue University and entered the power business as an engineer with the Wabash Valley Traction Company of Fort Wayne in 1905. Two years later he was appointed to the railroad commission of Wisconsin.

When the public utilities commission of Illinois was created in 1913 he became its first chief engineer. In 1929 he was elected head of the Indiana Service Corporation, an electric light and power and electric railway company with headquarters at Fort Wayne. Although an active operator, Mr. Feustel continued to serve on various state utility commissions and did considerable evaluation work for the Dominion of Canada.

In 1929 Mr. Feustel was elected vice-president of the Midland United Company, which controls several public utility companies operating in Indiana and Ohio, including the Indiana Service Corporation. He became president of Midland in December, 1931.

PERSONALS

GEORGE F. OXLEY has resigned as director of information and service of the National Electric Light Association after twelve years of service at the New York headquarters. Prior to his connection with the association, Mr. Oxley was secretary of the Colorado State Public Utilities Commission.

J. PAUL CLAYTON, vice-president of the Middle West Utilities Company, has been elected president of the Central Illinois Public Service Company to succeed MARSHALL E. SAMPSELL, who resigned earlier in the year. Mr. Clayton was operating vice-president of the Central Illinois company for thirteen years until last January, when he was promoted to the position of vice-president in charge of operations of the Middle West Utilities Company, of which the Central Illinois company is a subsidiary.

OTTO H. FALK, president of the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., since 1913, has just been elected chairman of the board of directors. MAX W. BABB, vice-president of the company since 1913, has been elected president to succeed Mr. Falk.

HAROLD H. WATSON has been appointed general superintendent of construction of the Northern States Power Company, Minneapolis, Minn., to succeed the late WILLIAM T. WALKER, who died on Feb. 25. For the past ten years Mr. Watson has been in charge of special construction work for the San Diego Consolidated Gas & Electric Company. GEORGE F. PHYTHIAN, in charge of construction work for the California Oregon Power Company and the Mountain States Power Company, will extend his duties to include the San Diego company.

How's Business?

Looking backward over the course of the basic business and financial indicators during the past two months, anyone not completely poisoned by the pervasive pessimism that has accompanied this depression must be somewhat impressed by the scattered signs suggesting that most of the destructive force of the decline may have spent itself, and that some sort of uncertain equilibrium is being slowly established at current levels, says *The Business Week*, May 18. Although employment and retail trade appear still to be declining, activity in steel, building and other basic industries seems to have settled around an irreducible minimum. The precipitate downward movement of commodity prices has slackened, and in some instances ceased. The broad averages of security prices have been fairly steady for several weeks. Most striking of all is the slowly emerging evidence that the catastrophic contraction of credit in our Federal Reserve system has been checked.

Utility power production for the week ended May 7 was 1,429,032,000 kw.-hr., 12.7 per cent under that for the corresponding period last year, according to the N.E.L.A.

New Plant Construction

Compiled by the McGraw-Hill Business News Department, Which Is Prepared to Furnish a More Complete Daily Service to Those Who Wish It

Calif., Camarillo—State Department of Institutions, Sacramento, acquired a site and plans construction of first unit of state mental hospital in Ventura county near here. $375,000. Estimated total cost $3,000,000. G. B. McDougall, Sacramento, is state architect.

Calif., Vernon—City Council, will receive bids until May 23 for construction of a 170 x 240 ft. power plant on De Soto St. Estimated cost $150,000. Howard S. McCurdy, City Hall, is engineer.

Conn., Mystic—Mystic Ice Co., F. Bergman, Mgr., Noank Road, Noank, awarded contract for construction of a 20 ton ice plant here, to N. & S. Building Co., Main St., Norwich. Estimated cost $40,000.

Ill., Springfield—City awarded contract for a 10,000 kw. turbine to General Electric Co., Schenectady, N. Y. $156,000. Will soon receive bids for boiler and condenser.

Ia., Sioux City—Palmer Candy Co., C. Blomberg, Supt., 209 Douglas St., plans remodeling 1 story, 50 x 150 ft. ice plant at 207 Douglas St. Estimated cost $60,000. Private plans. Work will be done by day labor. Sub-contracts awarded."

Mass., Medfield—Commonwealth of Massachusetts, Department of Mental Diseases, awarded contract for construction of a waterworks pumping station to H. C. Hanson, 49 Pond St., Jamaica Plain and equipment to Rideout Chandler & Joyce, 130 Broad St., Boston. Total cost $22,327.

Mass., Worcester—Holy Cross College, J. M. Fox, having plans prepared for construction of a group of buildings including dining hall, boiler house, laundry, office, etc. Estimated cost $300,000. Maginnis & Walsh, Statler Bldg., Boston, are architects.

Mo., St. Charles—Russell & Axon, Roosevelt Bldg., St. Louis, Conslts. Engrs., reported to City Council of St. Charles that a municipal light and power plant for that community could be built with the proceeds of a $300,000 bond issue. Report stated that a steam generating plant can be built for $200,130 or Diesel engine plant for $167,937 and distribution system. $91,350.

N. J., Hackensack — Sears-Roebuck & Co., Arthington and South Homan Ave., Chicago, Ill., awarded contract for construction of a 3 story department store at Main and Anderson Sts. here, to Walter Kidde Constructors, 140 Cedar St., New York. Estimated cost $1,000,000.

N. J., Jersey City—M. C. Provision Co., 414 Hoboken Ave., receiving bids for alterations to refrigeration plant. Estimated cost $40,000. Construction Service Corp., 80 Broad St., Elizabeth, is architect.

N. J., Perth Amboy—Raritan Copper Works, plans reconstruction of plant destroyed by explosion including installation of boiler and boiler house at Elm and Market Sts. Estimated cost to exceed $40,000.

N. Y., Brooklyn — H. Hesterberg, Pres. of Borough of Brooklyn, Borough Hall, awarded contract for sewers, sewage pumping plant and equipment to Russell Contracting Co., 8502 91st Ave., Woodhaven, $568,602.

N. Y., Brooklyn—Silver Home Construction Co., 499 Pennsylvania Ave., plans construction of a 1 story, 40 x 98 ft. market building including refrigeration plant at Livonia and Sheffield Aves. S. Millman, 1780 Pitkin Ave., is architect.

N. Y., High Falls—Department of Water, Gas & Electricity, Municipal Bldg., New York, plans construction of electric power plant as part of its Rondout creek reservoir project here. Court of Appeals dismissed objections for private companies upholding approval of the State Water, Power and Control Commission.

N. Y., New York—Springler Electric Corp., c/o Smith, Chambers & Clare, 60 Broadway, Attys., 60 Broadway, organized by interested property owners, plans construction of a steam power plant and distribution system to serve area between 13th and 15th Sts., Union Square and University Place W. to west side of Fifth Ave. Esitmated cost $600,000. Hearing on franchise application May 25.

Okla., El Reno—Liebmann's Independent Ice Co., 200 South Klein St., Oklahoma City, awarded contract for construction of a 25 ton ice plant here, to F. Corlee, El Reno. Estimated cost $25,000.

Okla., Lawton—Owner, c/o Guy Dale, 307 Koehler Bldg., Archt., awarded general contract for construction of an ice plant to Q. R. Shelton, 1324 First National Bank Bldg., Oklahoma City. Estimated cost $40,000. Equipment contract let.

Pa., Pittsburgh—Department of Welfare, Education Bldg., Harrisburg, having preliminary plans prepared for construction of a psychiatric hospital at O'Hara and DeSota Sts. here. Estimated cost $2,000,000. Louis Stevens, Century Bldg., Pittsburgh, is architect.

Va., Culpeper — Virginia Public Service Co., plans reconstruction of power plant destroyed by fire. Estimated cots to exceed $50,000.

Wash., Seattle—City will soon receive bids for construction of 43rd Street sewer system. This is fourth unit of five to be built to divert sewage from Lake Washington to the Sound and will extend from Denny Blaine Place on Lake Washington Blvd., a distance of 7,700 ft. along the lake shore. Plans include two pumping plants. Estimated cost $100,000.

Man., Winnipeg — City, H. A. Morton, 55 Princess St., plans extensions and additions to hydro electric system, also hydro steam heating plant. Estimated total cost $440,000. J. W. Sanger is chief engineer, R. H. Andrews is electrical engineer. Work will be done by owner's forces.

Equipment Wanted

Air Compressors—Washington, D. C.—Procurement Division, Veterans' Administration, will receive bids until May 24 for air compressors during a six or twelve months' period. Cir. 488-M.

Boiler—Colorado Springs, Colo.—City Commission, will receive bids until May 26 for new boiler for municipal power plant.

Boilers—Coshocton, O.—Treasury Department, Office of Supervising Architect, Washington, D. C., will receive bids until June 6 for new heating boilers, etc., for Post Office here.

Boilers—Portland, Ore.—U. S. Engineer Office, Customhouse, will receive bids until June 2 for furnishing and installing two boilers capable of generating in total 45,000 lb. steam per hour for U. S. Dredge "Co. P. S. Michie" on Willamette River at government moorings.

Boilers, Stokers, etc.—Wilmington, Del.—State of Delaware, Old Age Welfare Commission, 800 Equitable Bldg., will receive bids until May 23 for two 150 hp. cross-drum water tube boilers, stokers, beeching, etc.

Conduit and Transformers—Cleveland, O.—City will receive bids until May 20 for fibre conduit and transformers.

Evaporator and Condenser—Vicksburg, Miss.—U. S. Engineer Office, will receive bids until May 20 for marine evaporator and steam condenser. Also until May 25 for reduction gear unit.

Hoists—Washington—Bureau of Reclamation, Denver, Colo., will receive bids until June 16 for one motor-operated tandem cylinder gate hoist, with capacity of 364,000 lb. for bottom gate and 270,000 lb. for top gate with stems and other accessories; two cylinder gates with outside diameters of 20 ft. 2¼ in. and 19 ft. 10 in. together with guides and seats for installation in outlet works at Cle Elum Dam, Yakima, project here.

Lighting Standards, Transformers, Switchboard Panel, etc.—Quantico, Va.—Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until May 25 for lighting standards, cables, ducts, potheads, transformers, switchboard panel, insulators and all accessories to complete street lighting system at Marine Barracks here. Spec. 6718.

Pumping Equipment—Swampscott, Mass.—Sewer Department, will receive bids until June 2 for furnishing and installing pumping equipment including shafts, piping, valves, etc., for Humphrey St. pumping station.

Pumps—Weston, Ont.—Town, plans to purchase deep well pumps, etc., in connection proposed waterworks improvements. Estimated cost $35,000.

Switchboard—Westmount, Que.—City Engineer plans to purchase switchboard for electrical power plant.

Water Systems—Columbus, O.—Department of Public Welfare, Ninth and Oak Sts., J. McSweeney, Dir., will receive bids until June 10 for pumping, heating and boiler feed water systems for Ohio penitentiary.

BUSINESS NOTES

GRISCOM-RUSSELL COMPANY, New York City, announces the removal of its Dallas (Tex.) district office to 501 Tower Petroleum Building.

GEARS AND FORGINGS, INC., Cleveland, Ohio, although in the hands of receivers, is operating an usual. This announcement is made by the company to contradict rumors that its operations had been discontinued. This is a friendly receivership proceeding, the announcement states, and all work is being carried forward in the usual manner by the same workmen as before. The business will be conducted as heretofore pending a reorganization of the company's financial structure.

AMERICAN CABLE COMPANY, New York City, announces that the Macwhyte Company, Kenosha, Wis., has recently been licensed to manufacture preformed wire rope under the American Cable Company's patents.

SULLIVAN MACHINERY COMPANY, Chicago, Ill., announces the removal of its branch office at Knoxville, Tenn., from 623 Market Street to new quarters at Suite 803, Medical Arts Building. E. L. Thomas is manager of this office.

COMBUSTIONEER, INC., formerly of Goshen, Ind., has moved its executive offices and factory to Columbia St. and Bechtle Ave., Springfield, Ohio.

STATIC CONDENSERS—A simple discussion of the meaning of power factor and how it can be corrected by static condensers is given in a new bulletin of the Dubilier Condenser Corporation, 4377 Bronx Blvd., New York, N. Y. The bulletin contains an ingenious scale whereby the condenser capacity required or any given power factor correction may be instantly determined.

OIL BURNERS—An illustrated description of the Hammel patented oil burner for high-pressure steam boilers using steam or air for atomization, is given in a new bulletin issued by the Hammel Oil Burner Company, 724 West Vernon Ave., Los Angeles, Calif.

DIESEL ENGINES—Bulletin No. 124, just issued by the Superior Engine Company, Springfield, Ohio, describes and illustrates the company's four-cycle solid-injection stationary diesel engines, which are built in capacities of from 135 to 840 horsepower.

PUMPS, COMPRESSORS—Worthington Pump and Machinery Corporation, Harrison, N. J., has just issued three new bulletins on pumps and compressors, as follows: W-321-S1A covering construction, ratings and characteristics of monobloctype centrifugal pumps; D-450-B7 describing vertical sump and irrigation pumps; and W-850-B5 showing mechanical features of portable air compressors.